International Fertilizer Development Center
Annual Report 1997

"Nutrients to Feed Plants That Nourish People"

IFDC's Mission

To increase and sustain food and agricultural productivity in developing countries through the development and transfer of effective and environmentally sound plant nutrient technology and agribusiness expertise.

Center Profile

IFDC is a public, international, nonprofit organization, which was founded in 1974. The Center focuses on increasing and sustaining food and agricultural productivity in developing countries through the development and transfer of effective and environmentally sound plant nutrition technology and agribusiness expertise. The Center has conducted technology transfer initiatives in more than 100 countries. It has enhanced the development of human resources in more than 145 countries through some 500 training programs.

IFDC's work concentrates on these broad areas: market development; natural resource and environmental management; human capacity building; nutrient access; and nutrient efficiency. IFDC's organizational structure for the 1990s includes three operating divisions: (1) Outreach – which concentrates on technology transfer related to efficient operations of the fertilizer and agriculture sectors; (2) Research and Development – which conducts strategic and applied research in nutrient management and soil fertility; and (3) IFDC-Africa, located in Lomé, Togo – which addresses the constraints to improving agricultural productivity of countries in West Africa.

At present IFDC has offices and/or outposted staff located in Albania, Bangladesh, Burkina Faso, Colombia, Niger, Peru, Togo, Ukraine, Uruguay, Venezuela, and Washington, D.C. The Center has linkages with numerous national, international, private-sector, and nongovernmental organizations around the globe. Our partners and clients are diverse and include bilateral and multilateral development agencies, host-government institutions, and private enterprises.

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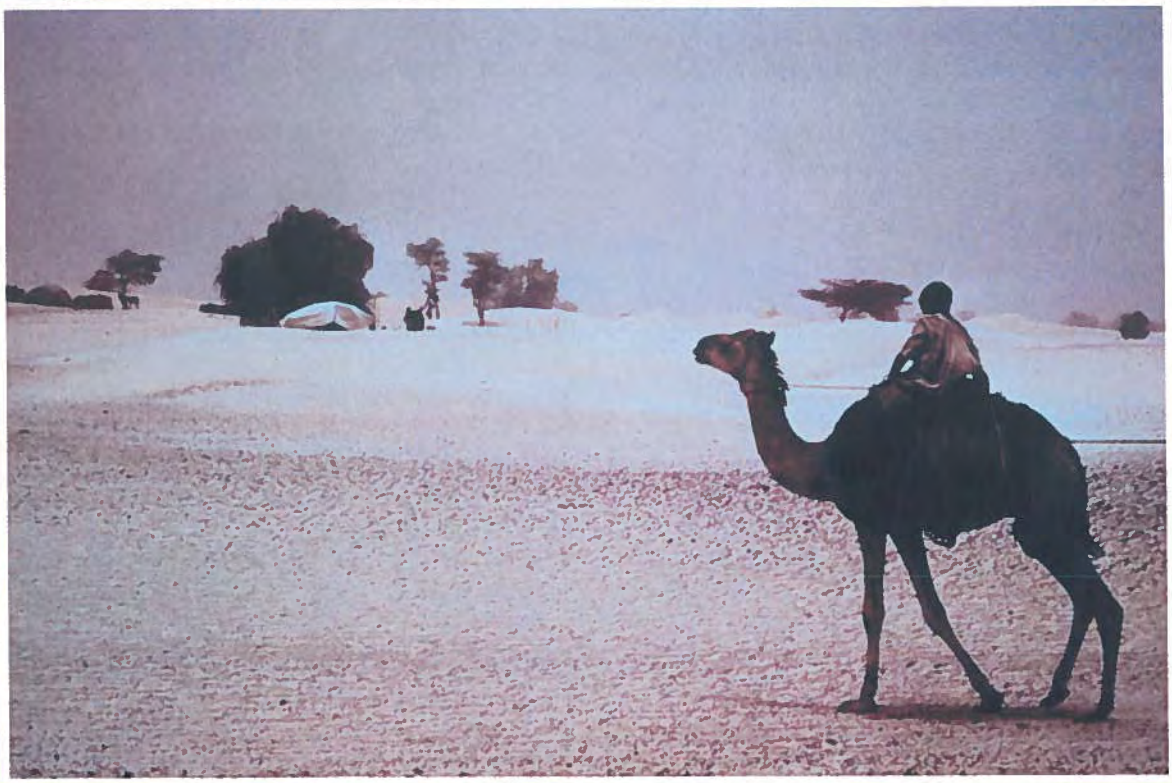


Acronyms

AFADA Affiliate Development Center (AADC)
Agro-Based Industry and Technology Development Project (ATDP)
Albanian Fertilizer and Agribusiness Dealers' Association (AFADA)
Asian Vegetable Research and Development Center (AVRDC)
Australian Centre for International Agricultural Research (ACIAR)
advanced very high resolution radiometer (AVHRR)
Bangladesh Agricultural Research Council (BARC)
Bangladesh Rice Research Institute (BRRI)
Bangladesh Rural Advancement Committee (BRAC)
Bangladesh Agricultural Research Institute (BARI)
Bureau of Alcohol, Tobacco, and Firearms (BATF)
Centro Internacional de Agricultura Tropical (CIAT)
Citizens' Network for Foreign Affairs, Inc. (CNFA)
Climate Prediction Center (CPC)
Collaborative Research Support Program (CRSP)
Consortium for the Sustainable Development of the Andean Ecoregion (CONDESAN)
Consultative Group on International Agricultural Research (CGIAR)
crop protection chemicals (CPCs)
cyclohexyl phosphorictriamide (CHPT)
Decision Support System (DSS)
Decision Support System for Agrotechnology Transfer (DSSAT)
Directoraat Generaal voor International Samenwerking (DGIS)
encapsulated calcium carbide (ECC)
El Niño/Southern Oscillation (ENSO)
Environmental Protection Agency (EPA)
European Fertilizer Manufacturers' Association (EFMA)
European radar remote sensing satellite - Synthetic Aperture Radar (ERS-SAR)
Fertilizer Working Group (FWG)
Food and Agriculture Organization of the United Nations (FAO)
Geographic Information System (GIS)
gross domestic product (GDP)
information and decision support systems (IDSS)
Indian Council of Agricultural Research (ICAR)
Instituto Nacional de Investigación Agropecuaria (INIA)
Instituto Agronomico de Parana (IAPAR)
international agricultural research centers (IARCs)
International Consortium for Agricultural Systems Application (ICASA)
International Fertilizer Development Center (IFDC)
International Fertilizer Industry Association (IFA)
International Food Policy Research Institute (IFPRI)
International Fund for Agricultural Development (IFAD)
International Potato Center (CIP)
International Research Institute for Climate Prediction (IRI)
International Rice Research Institute (IRRI)
International Service for National Agricultural Research (ISNAR)
National Aeronautics and Space Administration (NASA)
National Agricultural Research Center – Uruguay (INIA)
national agricultural research systems (NARS)
National Oceanic and Atmospheric Administration (NOAA)
New Independent States (NIS)
nongovernment organizations (NGO)
Petroquimica de Venezuela SA. (PEQUIVEN)
private sector extension system (PSES)
Soil Fertility Initiative (SFI)
Soil Fertility Management Unit (SFMU)
Soil, Water, and Nutrient Management (SWNM)
Sub-Saharan Africa (SSA)
The Fertilizer Institute (TFI)
United Nations Environment Programme (UNEP)
United Nations Industrial Development Organization (UNIDO)
United States Agency for International Development (USAID)
urea supergranules (USG)

Note: In this report all references to "tons" are "metric tonnes" unless otherwise specified.

Preface

Message From the Chairman of the Board

My association with IFDC dates back more than two decades. When I was President of the International Development Research Centre of Canada, I had the pleasure of approving partial funding for the establishment of IFDC. For the past 17 years I have been a member of the IFDC Board of Directors; almost one-half of that time I have served as the Board's Chairman.

As I look back on my tenure at IFDC as Chairman of the Board, three significant events stand out: (1) the appointment of Dr. Amit H. Roy as President and Chief Executive Officer, who has continued the excellent traditions established by IFDC's first Managing Director, Dr. Donald L. McCune; (2) the expansion of the Board of

Directors to include representation from the U.S. and global fertilizer industry; and (3) the extension of IFDC's activities into agribusiness development and fertilizer manufacturing activities in the third world. During my tenure with IFDC we have been fortunate in having the support of a loyal group of donors. We appreciate the valuable assistance that we have received over the past two decades. Through greater collaboration with both national and international institutions, IFDC will continue to be a vital force in the agricultural development arena.

Now it is time for me to turn over the gavel to the able hands of Dr. E. Travis York, who has been selected to chair the IFDC Board and guide the Center as we approach the new millenium. Dr. York is Chancellor Emeritus of Florida's state university system, a distinguished service professor emeritus at the University of Florida's Institute of Food and Agricultural Sciences (which he established), and a world renown advisor on international agricultural development.

York's illustrious career in agriculture has featured more than 100 appointments, assignments, and other professional activities, which were conducted both domestically and abroad in more than 80 countries. Some of these appointments have been made by Presidents Kennedy, Johnson, Nixon, Ford, Carter, and Reagan. He has served as a consultant for the U.S. State Department, U.S. Agency for International Development, White House, United Nations, foreign governments, and many universities in the fields of education, agriculture, and economic development.

Under Dr. York's able leadership I am confident that IFDC will contribute significantly to agricultural development in the developing world.

W. David Hopper
Chairman of the Board

Message From the President and Chief Executive Officer

The United Nations projects a global population of 8 billion for the year 2025 and 9.4 billion for 2050. Between now and 2050 world population growth will be generated primarily in developing countries. Scientists, policy makers, and development specialists face the daunting challenge of creating food security as the developing world's population continues to expand into the next century and the availability of suitable agricultural land decreases. No one organization can tackle this challenge alone; it requires diverse partnerships working toward a common goal. During 1997 IFDC forged partnerships with governments,

universities, nongovernment organizations, and private and public organizations to enhance its achievements in the areas of nutrient management, resource conservation, and environmental protection; management information systems; market development; and human resource development and capacity building.

IFDC's researchers during 1997 continued to apply research results and information to expand the productivity of the land already being cultivated in Asia, Africa, Latin America, and Eastern Europe. To allow people an opportunity to escape the never-ending spiral of poverty, IFDC continued to focus its commitment on employment generation through its agribusiness activities in Albania, Bangladesh, and various countries in Africa.

In this annual report we focus on those activities that promote the efficient use of "Nutrients to Feed Plants That Nourish People," the theme of this year's report. Besides the work at Headquarters, the efforts of IFDC staff posted in Albania, Bangladesh, Colombia, Niger, Peru, Philippines, Togo, Ukraine, Uruguay, and Venezuela are covered.

The year 1997 brought an increasing demand for IFDC's unbiased opinion and assistance regarding various facets of agricultural sector development. With the continued support of a loyal group of donors and a staff that is both internationally and technically diverse, IFDC should be able to expand its influence in the agricultural development arena in the future.

Dr. Amit H. Roy
President and Chief Executive Officer

Prefacio

Mensaje del Presidente de la Junta

Mi asociación con el IFDC se remonta más de dos décadas. Siendo Presidente del Centro Internacional para la Investigación y el Desarrollo (CIID) de Canadá, tuve el placer de aprobar una contribución parcial para el establecimiento del IFDC. Durante los últimos 17 años he sido miembro de la Junta Directiva del IFDC, y durante casi la mitad de ese tiempo serví como Presidente de esa Junta.

Al recordar mi tenencia en el IFDC como Presidente de la Junta Directiva, sobresalen tres eventos significativos: (1) el nombramiento del Dr. Amit H. Roy como Presidente y Jefe Ejecutivo, quien ha continuado las tradiciones del primer Director Gerente del IFDC, el Dr. Donald L. McCune; (2) la expansión de la Junta Directiva incluyendo la representación de la industria de fertilizantes de los Estados Unidos y

global; y (3) la extensión de las actividades del IFDC hacia el desarrollo de los agronegocios y actividades de manufactura de fertilizantes en el tercer mundo. Durante mi tenencia en el IFDC hemos tenido la suerte de contar con el apoyo de un grupo leal de donantes. Apreciamos la valiosa asistencia que hemos recibido durante las últimas dos décadas. A través de una mayor colaboración con instituciones nacionales e internacionales, el IFDC continuará siendo una fuerza vital en el área del desarrollo agrícola.

Ahora me toca pasar el mando a las hábiles manos del Dr. E. Travis York, quien ha sido elegido para ocupar la Presidencia de la Junta del IFDC, y guiar al Centro al acercarnos al nuevo milenio. El Dr. York es Canciller Emérito del sistema de universidades del estado de la Florida, profesor emérito de servicio distinguido del Instituto de Alimentos y Ciencias Agrícolas de la Universidad de la Florida (instituto que fuera establecido por él), y asesor con reconocimiento mundial en el desarrollo agrícola internacional.

La carrera ilustre de York en agricultura, incluye más de 100 nombramientos, asignaciones, y otras actividades profesionales realizadas tanto dentro de los Estados Unidos como en más de 80 países. Algunos de estos nombramientos fueron hechos por los presidentes de los Estados Unidos, Kennedy, Johnson, Nixon, Ford, Carter, y Reagan. El ha servido como consultor para el Departamento de Estado de los Estados Unidos, para la Agencia Estadounidense para el Desarrollo Internacional (USAID), para la Casa Blanca, para las Naciones Unidas, para gobiernos de otros países, y para muchas universidades en los campos de educación, agricultura, y desarrollo económico.

Bajo la dirección idónea del Dr. York, estoy seguro de que el IFDC contribuirá en forma significativa al desarrollo agrícola en el mundo en vías de desarrollo.

W. David Hopper
Presidente de la Junta

Mensaje del Presidente y Jefe Ejecutivo

Las Naciones Unidas pronostican una población mundial de 8 mil millones de habitantes para el año 2025 y de 9.4 mil millones para 2050. De ahora al 2050 el crecimiento de la población va a llevarse a cabo primordialmente en los países en desarrollo. Los científicos, forjadores de políticas, y especialistas en desarrollo encaran el reto de crear la seguridad alimenticia a medida que la población mundial continúa expandiéndose en el nuevo siglo a la vez que diminuye la disponibilidad de terrenos agrícolas. Ninguna organización puede encarar sola este reto; se requiere el trabajo de muchos hacia una meta común. Durante 1997 el IFDC estableció relaciones con gobiernos, universidades, organizaciones

no-gubernamentales, y con entidades privadas y públicas para acentuar los logros en las áreas de manejo de nutrientes, preservación de recursos, y protección ambiental; sistemas de manejo de información; desarrollo de mercados; y desarrollo de recursos humanos, y de potencialidad.

Durante 1997, los investigadores del IFDC continuaron la aplicación de resultados de investigaciones e informaciones al aumento de la productividad de tierras bajo cultivos en Asia, Africa, América Latina y Europa Oriental. Para brindar un escape a la espiral de pobreza, el IFDC continuó su labor de ayudar a crear empleos en actividades de agronegocios en Albania, Bangladesh, y varios países en Africa.

En este informe anual hemos hecho enfoque en las actividades que promueven el uso eficiente de "Nutrientes que Alimentan Plantas que Nutren a la Humanidad," tema de éste informe. Se cubre aquí no sólo el trabajo realizado por el personal de la Sede del IFDC, sino también la labor realizada por el personal estacionado en Albania, Bangladesh, Colombia, Filipinas, Niger, Perú, Togo, Ucrania, Uruguay y Venezuela.

El año de 1997 trajo una creciente demanda por la opinión y la asistencia imparcial del IFDC respecto a varios aspectos del desarrollo del sector agrícola. Con el continuado apoyo de un grupo leal de donantes y de un personal que es diverso técnica e internacionalmente, el IFDC debe poder expandir su influencia en el campo del desarrollo agrícola en el futuro.

Dr. Amit H. Roy
Presidente y Jefe Ejecutivo

Préface

Message du Président du Conseil d'Administration

Mes relations avec l'IFDC remontent à plus deux décennies. Dans le cadre de mes fonctions de Président du Centre de recherches pour le développement international du Canada, j'eus le plaisir d'approuver un financement partiel pour l'établissement de l'IFDC. Pendant les dix-sept dernières années, j'ai fait partie du Conseil d'administration de l'IFDC, la moitié de ce temps comme son président.

Un regard rétrospectif sur la période durant laquelle j'étais Président du Conseil fait ressortir trois faits marquants: (1) la nomination au poste de Président-directeur général de Dr. Amit Roy qui a su maintenir les excellentes traditions instituées par le premier Directeur général Dr. Donald L. McCune; (2) la représentation, au sein du Conseil, des Etats-Unis et de l'industrie mondiale des engrais; et (3) l'élargissement du champ

d'intervention de l'IFDC pour inclure le développement d'agro-industries et des activités de production d'engrais dans les pays en développement. Durant cette période également nous avons eu la chance d'obtenir l'appui d'un groupe de donateurs fidèles. C'est l'occasion de leur renouveler notre gratitude pour l'aide inestimable qu'ils nous ont apportée au cours des deux dernières décennies. En renforçant sa collaboration avec les institutions nationales et internationales, l'IFDC restera une force motrice dans la sphère du développement agricole.

Le moment est venu pour nous de remettre le maillet entre les mains expertes de Dr. Travis York qui a été choisi pour présider le Conseil d'administration de l'IFDC et guider le Centre à l'approche du troisième millénaire. Dr. York est chancelier émérite de l'Université d'Etat de la Floride, un éminent professeur de l'Institute of Food and Agricultural Sciences de la Floride (qu'il a contribué à mettre sur pied) et un conseiller mondialement reconnu dans le domaine du développement agricole international.

L'illustre carrière de York en agriculture est marquée d'une centaine de nominations et de diverses activités professionnelles exercées soit à l'intérieur, soit à l'étranger dans plus de quatre-vingt pays. Certaines de ces nominations émanèrent des Présidents Kennedy, Johnson, Nixon et Reagan. Il a été consultant auprès du Département d'Etat américain, de l'Agence américaine pour le développement international (USAID), de la Maison Blanche, des Nations Unies, de gouvernements étrangers et de nombreuses universités dans les domaines de l'éducation, de l'agriculture et du développement économique.

Sous la direction éclairée de Dr. York, j'ai la certitude que l'IFDC apportera une contribution significative au développement agricole dans les pays en développement.

W. David Hopper
Président Honoraire du Conseil

"Des éléments nutritifs pour les plantes qui nourrissent les hommes"

Message du Président-Directeur Général de l'IFDC

Selon les prévisions des Nations Unies, la population mondiale atteindra 8 milliards de personnes en l'an 2025 et 9,4 milliards en 2050. Entre le moment présent et l'année 2050, la croissance de la population mondiale sera issue principalement des pays en développement. Les scientifiques, les décideurs et les spécialistes du développement doivent faire face au redoutable défi d'assurer la sécurité alimentaire à une population en constante croissance, tandis que les disponibilités en terres agricoles s'amenuisent. Aucune organisation ne peut relever seule ce défi qui requiert un partenariat multiple et diversifié dans la poursuite d'un objectif commun. Ainsi, au cours de l'année 1997, l'IFDC est entré en partenariat avec des gouvernements, des universités, des organisations non

gouvernementales et des institutions publiques et privées afin d'améliorer ses performances dans les domaines de la gestion des éléments nutritifs, la conservation des ressources naturelles, la protection de l'environnement, les systèmes de gestion de l'information, le développement de marché, le développement des ressources humaines et le renforcement des capacités.

Cette année également, les chercheurs de l'IFDC ont intensifié les efforts en vue de mettre en pratique les résultats des recherches et les informations disponibles pour accroître la productivité des terres déjà cultivées en Asie, en Afrique, en Amérique Latine et en Europe de l'Est et aider ainsi les populations à sortir de la spirale interminable de la pauvreté. De même, l'IFDC a focalisé son action sur la création d'emplois en favorisant le développement d'agro-industries en Albanie, au Bangladesh et dans divers pays africains.

Dans le présent rapport annuel, nous mettons l'accent sur les activités aptes à promouvoir l'utilisation efficace "Des éléments nutritifs pour les plantes qui nourrissent les hommes." C'est là le thème central de ce rapport qui couvre non seulement les actions menées au siège, mais encore les efforts déployés par le personnel de l'IFDC en poste dans divers pays dont l'Albanie, le Bangladesh, la Colombie, le Niger, le Pérou, les Philippines, le Togo, l'Ukraine, l'Uruguay, et le Venezuela.

L'année 1997 a vu émerger une demande croissante pour l'assistance et les conseils objectifs de l'IFDC concernant divers aspects du développement agricole. Avec l'appui continu d'un groupe de donateurs fidèles et un personnel international et multidisciplinaire hautement qualifié, l'IFDC devrait être en mesure d'étendre et d'affermir son influence dans la sphère du développement agricole.

Dr. Amit H. Roy
Président-Directeur Général de l'IFDC

Executive Summary

The theme of this annual report is "Nutrients to Feed Plants That Nourish People." IFDC's scientists and specialists in agribusiness and human resource development promote the balanced and efficient use of plant nutrients from both organic and inorganic sources to intensify agriculture in a sustainable manner.

The following paragraphs summarize IFDC's 1997 activities in the areas of market development, natural resource management and environmental protection, management information systems, and human capacity building.

Market Development

- The 5-year Agro-Based Industries and Technology Development Project (ATDP), which began in mid-1995 in Bangladesh, focuses on increasing productive employment in the agriculture sector through the stimulation of private sector investment in the production and marketing of commercial agricultural inputs, outputs, and technologies in an open and competitive market environment. With support from the United States Agency for International Development (USAID), the project addresses these subsectors: seeds and field crops; fertilizer; horticulture; livestock; poultry; fisheries; agrimachinery and agroprocessing equipment; and agroprocessing.
- Since the inception of the ATDP project, private sector investment in agribusiness activities has increased to US $120 million; the entrepreneurs currently have a 40% equity in the various business enterprises.
- Through the use of improved technologies and the development of markets for agricultural products as promoted by the Bangladesh project, farm income and agribusiness employment in the pilot zones have greatly exceeded project goals, sometimes fourfold the expected outcome. Currently about 150,000 farmers and agribusiness employees are benefiting from the project through expanded employment opportunities and increased family income.
- As the ATDP project continues, the lessons learned and the technical/economic/policy results demonstrated in the four pilot zones are expected to be broadly integrated into Bangladesh's overall agriculture sector.
- The political and economic turmoil in Albania during 1997 immobilized most development activities in that country. USAID's and IFDC's decisive direction kept the project active although all expatriate personnel were evacuated. Against this backdrop, the Albanian Fertilizer and Agricultural Inputs Dealers Association (AFADA) managed to maintain fertilizer and agricultural activity in the country with the assistance of the USAID/IFDC project.
- By late-1997, 81.5% of Albanian farmers used inorganic fertilizer, compared with 63% in 1994. Maize yields climbed to 2.8 mt/ha, compared with 1.8 mt/ha in 1994. Production of wheat, maize, and white beans increased from 467,000 mt in 1996 to 480,000 mt in 1997. The import and safe use of crop protection chemicals more than doubled from 1996 to 1997, and imports of fertilizers increased 17% over 1996 values. Laboratories were established for the Soil Science Institute and the National Seed Institute.

- Despite Venezuela's economic downturn during 1997, which impacted the production and sales of Petroquimica de Venezuela S.A. (PEQUIVEN), a significant rehabilitation resulting in more efficient and sustained operation of the PEQUIVEN ammonia plant was completed in mid-1997. Concurrent with the rehabilitation of the ammonia plant, the urea plant was also upgraded. As a result, the consumption of ammonia per ton of urea was lowered to a level that is now consistent with the state-of-the-art practice worldwide. (Since mid-1994 IFDC has been assisting PEQUIVEN, a state-owned company, in making the transition to a market-driven enterprise.)
- PEQUIVEN, with IFDC assistance, continued to address during 1997 the issues of product quality (particularly that of phosphoric acid and compound NPKs), raw material consumption per unit of production, environment and safety, and preventive maintenance. These efforts led to a general improvement in NPK product quality, more efficient use of raw materials, less environmental pollution, and a decrease in emergency shutdowns.
- As a subcontractor to the Citizens Network for Foreign Affairs, Inc. (CNFA), IFDC is contributing to a 3-year USAID cooperative agreement, "Agribusiness Partnership Program, Phase II for Ukraine, Moldova, and Belarus: The Food Systems Restructuring Project." The Agribusiness Partnership Program is dedicated to empowerment of locally owned, successfully operated, private agribusinesses in the western New Independent States (NIS) through linkages with U.S. agribusinesses. USAID funding plays a critical catalytic role in engaging invested U.S. private sector enterprises to undertake targeted development activities that address critical up- and downstream blockages in the food systems of the western NIS and that are beyond the scope of their core business. Modest USAID resources generate significant new private investment capital, technology and real developmental impact that would not otherwise affect development of the western NIS. An IFDC agribusiness advisor, secunded to CNFA/Kiev, is working with partnerships dealing with fertilizer blending and marketing, agrichemical marketing, grain handling and storage, vegetable oil extraction, and formulation of concentrate and compound animal feed.

Natural Resource Management and Environmental Protection

- Three scientists from Russia, Syria, and Tanzania conducted their research work at IFDC Headquarters. The Russian scientist performed two studies to investigate (1) the effect of acidulation of two phosphate rocks containing high cadmium content on cadmium uptake by upland rice and (2) the effect of species of food grain crops (flooded rice, cowpea, soybean, wheat and oat) on cadmium uptake. All three scientists conducted evaluations of the agronomic effectiveness of their indigenous phosphate rocks and modified phosphate products as influenced by soil properties and crop species. One significant finding was that canola (rape) utilized phosphate rocks in neutral and alkaline soils whereas other crops failed to utilize it.
- IFDC continued to evaluate the important factors affecting the use of phosphate rocks for crop production. During 1997, the Center's scientists studied phosphate rocks from Algeria, Tunisia, and Jordan using upland rice, soybean, wheat, canola, and *Brachiaria decumbens* grass as testing crops. On acid soils, these phosphate rocks performed well with respect to water-soluble phosphate fertilizers. A 3-year agronomic field trial of Gafsa phosphate rock from Tunisia was initiated in three provinces of southeast China under different cropping systems.
- A collaborative project with the Asian Vegetable Research and Development Center (AVRDC) entered the third year to study cadmium uptake from applied phosphate fertilizers by different vegetable crops in Taiwan. Soil and plant samples were sent to IFDC to be analyzed for cadmium uptake.
- A significant finding from two greenhouse experiments was that Christmas Island C-grade phosphate rock, calcined at 550 degree Centigrade was very effective for flooded rice grown on acid, neutral, and alkaline soils. The material was also effective for upland rice grown on an alkaline soil. There are several million tonnes of C-grade phosphate stockpiled on the island as waste material. Now it is possible to use this material for flooded rice, especially in southeast Asia.

- In a collaborative project with the International Center for Tropical Agriculture (CIAT), an IFDC scientist posted in Colombia defined lime, magnesium, and potassium requirements for acid-soil tolerant varieties of rice, maize, cowpea, and soybean in rotational production systems on medium-textured Oxisols. He further quantified the residual effectiveness and maintenance requirements of lime applications to medium-textured savanna Oxisols. His research also showed that recycling of nitrogen, phosphorus, and potassium was greater when rice and maize were rotated with legumes, especially in green manures, rather than when grown in monocultures.
- In the first year of the "Collaborative Research Program for Soil Fertility Restoration and Management in Resource-Poor Areas of Sub-Saharan Africa (SSA)," the International Fund for Agricultural Development (IFAD) project tested the effect of soil fertility improvement on fertilizer use efficiency in on-station trials. IFDC-Africa established contacts for testing this concept during 1998 in on-farm experiments in four West African countries.
- During 1997 the International Fertilizer Industry Association (IFA) project entitled "Fertilizers and Sustainable Agricultural Development in West Africa: Strengthening Linkages Between Farmers, Fertilizer Dealers, Research and Extension Workers, and Policy Makers" made good progress. In contrast to 1996 the rains in 1997 favored maize growth in the three participating countries—Togo, Benin, and Niger. In all villages the number of participating farmers increased. IFDC-Africa initiated efforts to extend the project in the three participating countries and to begin activities in Ghana and Mali. These developments will result in a substantial increase in the number of villages participating in the project.

Management Information Systems

- During 1997, 86 scientists representing 30 institutions in the Andean region were trained in the use of process-based simulation models (DSSAT) during four one-week workshops conducted in Bolivia, Colombia, Ecuador, and Peru.
- A regional network of scientists from Andean institutions (MOS Andes) was formed to facilitate the exchange of information and methodologies for the study of nutrient management issues in Andean agroecosystems.
- A database of soil profile physical and chemical descriptions, recorded daily weather, and results from historical field experiments was assembled for model calibration and testing under Andean conditions.
- In collaboration with the National Oceanic and Atmospheric Administration (NOAA), IFDC scientists developed methods to start applying seasonal forecasts linked to El Niño/Southern Oscillation (ENSO) in the agricultural sector of the United States, Uruguay, and Brazil.
- IFDC scientists initiated the development of two new Information and Decision Support Systems (IDSS) for the agricultural sector of Uruguay and the state of Parana (Brazil). Developed in collaboration with the National Aeronautics and Space Administration (NASA) and NOAA, the new IDSSs will add satellite information and seasonal forecasts.
- In collaboration with Instituto Nacional de Investigación Agropecuaria (INIA)/Uruguay, IFDC crop modelers developed a predictive model to estimate the decomposition rates of different crop residues under conventional tillage and no-till conditions.
- In collaboration with INIA/Uruguay and the World Bank, IFDC scientists established in Uruguay a comprehensive research program including soil testing, plant analyses, and simulation models to develop a system for nitrogen fertilizer recommendations in crop production of the humid Pampas of South America.
- In collaboration with the International Food Policy Research Institute (IFPRI), IFDC researchers conceptualized and developed a computer program to link the biophysical models developed at IFDC and the economic models developed at IFPRI into an integrated bioeconomic model for use within the Alternatives to Slash and Burn project. These various components will be linked recursively to reflect the decision making process of small farmers in the forest margins of Brazil.

- As part of the Australian Centre for International Agricultural Research (ACIAR) project on improving efficiency and predictability of biological inhibitors to reduce nitrogen losses and enhance flooded rice productivity, IFDC scientists completed scientific modifications of the CERES-Rice model to reflect the data collected in field experiments. New fertilizer types, encapsulating both urease and nitrification inhibitors, were incorporated into the model and tested against measured data.
- In collaboration with the International Consortium for Agricultural Systems Applications (ICASA), IFDC crop modelers conducted two crop modeling workshops. The first, held in cooperation with the Indian Council of Agricultural Research (ICAR), was conducted at Modipuram, Uttar Pradesh, India. The second was held at IFDC Headquarters. International and domestic interest in crop simulation modeling remains strong.
- IFDC scientists collaborated with their counterparts from Michigan State University to develop a revised phosphorus submodel for modeling applications. The proposed modular format of the phosphorus submodel will facilitate integration of the phosphorus routines, including the dynamics of phosphate rock, into all of the existing DSSAT models.

Human Capacity Building

- With funding from the Netherlands Environmental Trust Fund, during 1997 IFDC's soil fertility specialists jointly organized in Lomé, Togo, with the World Bank an International Workshop on Development of National Strategies for Soil Fertility Recapitalization in Sub-Saharan Africa. One hundred and twenty scientists, economists, environmental specialists, and senior government officials from 26 countries attended the workshop, which developed a blueprint framework for a national soil fertility improvement action plan.
- In cooperation with the University of Georgia, University of Florida, and ICASA, during 1997 IFDC crop modelers organized at Headquarters an International Training Program on Computer Simulation of Crop Growth and Management Responses. The participants ran the CERES, CROPGRO, SUBSTOR, CROPSIM, CANEGRO and OILCROP models for simulation of crop growth, development, and response to water and nutrients.
- In cosponsorship with the European Fertilizer Manufacturers' Association (EFMA), IFA, The Fertilizer Institute (TFI), United Nations Industrial Development Organization (UNIDO), and United Nations Environment Programme (UNEP), IFDC environmental specialists organized in Atlanta, Georgia (U.S.A.), an International Workshop on Environmental Challenges of Fertilizer Production—An Examination of Progress and Pitfalls. The workshop discussed how the fertilizer industry can meet the environmental challenges facing it.
- In Lomé, Togo, IFDC specialists conducted an International Training Program on the Development of Fertilizer Recommendations Based on Field Experiments and Soil-Crop Models. The participants discussed strategies dealing with integrated plant nutrient management, management of organic and mineral fertilizers, and modeling and experimentation supporting fertilizer recommendations for efficient use of fertilizer.
- In cosponsorship with the Fertilizer Society of South Africa, IFDC organized and conducted in Pretoria, South Africa, an International Training Program on Fertilizer Marketing: Challenges and Opportunities. Techniques and skills needed to compete in a free and open market system were discussed.
- Specialized training programs on a wide variety of topics were conducted for individual scientists, engineers, and marketing specialists from Albania, Argentina, Bangladesh, China, Mexico, Pakistan, Russia, Syria, and Tanzania.

Resumen Ejecutivo

El tema de este informe anual es "Nutrientes que Alimentan Plantas que Nutren a la Humanidad." Los científicos y especialistas del IFDC en agronegocios y desarrollo de recursos humanos promueven el uso balanceado y eficiente de nutrientes de plantas provenientes de fuentes orgánicas e inorgánicas para intensificar la agricultura en forma sustentable.

Los párrafos siguientes resumen las actividades del IFDC en 1997 en las áreas de desarrollo de mercados, manejo de recursos naturales y protección ambiental, sistemas de manejo de información, y desarrollo de capacidad humana.

Desarrollo de Mercados

- El proyecto de 5 años para el Desarrollo de Industrias y Tecnologías Relacionadas con la Agricultura (ATDP) que comenzó en Bangladesh en 1995 se dedica a aumentar empleo productivo en el sector agrícola a través del estímulo de inversiones del sector privado en la producción y el mercadeo de insumos, productos, y tecnologías agrícolas en un ambiente de mercado abierto y competitivo. Con el patrocinio de la Agencia Estadounidense para el Desarrollo Internacional (USAID), el proyecto cubre los siguientes sub-sectores: semillas y cultivos de campo; fertilizantes; horticultura; ganado; aves de corral; pesquería; agroprocesos; y maquinaria agrícola y de agroprocesos.
- Desde el comienzo del proyecto ATDP, las inversiones privadas en actividades de agronegocios han aumentado a US $120 millones; los empresarios son actualmente dueños de un 40% de las varias empresas creadas.
- A través del uso de tecnologías mejoradas y del desarrollo de mercados para los productos agrícolas promovidos por el proyecto de Bangladesh, los ingresos de fincas y los empleos en agronegocios en las zonas pilotos han rebasado grandemente las metas del proyecto, a veces cuadruplicando éstas. En este momento unos 150.000 agricultores y empleados de agronegocios se benefician del proyecto a través de mayores oportunidades de empleo y de aumentos en los ingresos familiares.
- A medida que progresa el proyecto ATDP, se espera que las lecciones aprendidas y los resultados técnicos, económicos y de políticas demostrados en las cuatro zonas pilotos sean incorporados en forma general en el sector agrícola de Bangladesh.
- La mayor parte de la actividad de desarrollo en Albania fue inmobilizada por los disturbios económicos y políticos de 1997. La dirección decisiva de la USAID y del IFDC mantuvieron el proyecto a pesar de que todo el personal foráneo fue evacuado del país. En medio de todo ésto, la Asociación Albanesa de Distribuidores de Fertilizantes e Insumos Agrícolas (AFADA) logró mantener la actividad de fertilizantes y agrícola en el país con la asistencia del proyecto de USAID/IFDC.
- A finales de 1997, un 81.5% de los agricultores albaneses utilizaban fertilizantes en comparación con un 63% en 1994. Los rendimientos de maíz aumentaron a 2.8 tm/ha comparados con 1.8 tm/ha en 1994. La producción de trigo, maíz, y frijoles blancos incrementó de 467.000 tm en 1996 a 480.000 tm en 1997. La importación y el uso apropiado y seguro de plaguicidas se más que duplicó de 1996 a 1997, y las importaciones de fertilizantes aumentaron en un 17% por sobre los valores de 1996. Se establecieron laboratorios para el Instituto de Ciencias de Suelos y el Instituto Nacional de Semillas.

- A pesar de los problemas económicos de Venezuela durante 1997, los cuales impactaron en la producción y ventas de Petroquímica de Venezuela S.A. (PEQUIVEN), esta empresa logró ejecutar una rehabilitación importante de su planta de amoníaco a mediados de 1997. Al tiempo con esta rehabilitación, también se le hizo una serie de mejoras a la planta de urea. Como consecuencia, el consumo de amoníaco por tonelada de urea producida se bajó a niveles consistentes con las prácticas de plantas actuales en el mundo. (Desde mediados de 1994 el IFDC está colaborando con PEQUIVEN, una entidad estatal, para hacer la transición a empresa impulsada por las fuerzas del mercado.)
- Con la asistencia del IFDC, PEQUIVEN siguió trabajando en 1997 en la optimización de calidad de productos (particularmente en las áreas de ácido fosfórico y complejos NPK), en el consumo de materias primas por unidad de producción, en el medio ambiente y seguridad, y en el mantenimiento preventivo. Estos esfuerzos han conllevado a una mejora general en la calidad del producto NPK, en mejor eficiencia en el uso de materias primas, en menor contaminación ambiental, y en una disminución en las paradas de plantas por emergencias operacionales.
- Como subcontratista de la Red de Ciudadanos en Pro de Asuntos Extranjeros (CNFA), el IFDC está contribuyendo a un acuerdo colaborativo de 3 años de la USAID, el "Programa para Desarrollar Sociedades en Negocios Agrícolas, "Fase II para Ucrania, Moldova, y Bielorusia: Proyecto de Restructuración de Sistemas Alimenticios." Este programa está dedicado a fortalecer negocios agrícolas privados de los Nuevos Estados Independientes (NEI) operados eficazmente y pertenecientes a dueños locales, a través de enlaces con negocios agrícolas de los EE.UU. La financiación de la USAID juega un papel crítico y catalítico al permitir que las entidades de los EE.UU. acometan actividades de desarrollo fuera de su ámbito normal de negocios, que tiendan a eliminar bloqueos aguas arriba y aguas abajo de los sisstemas de alimentos en los países del NEI occidental. Recursos modestos de la USAID generan cantidades significativas de capital de inversión privada, de tecnología, y de impacto de desarrollo real en estos países que de otra manera no se hubiera generado. Un asesor de negocios agrícolas del IFDC, estacionado en Kiev, está trabajando con el CNFA en el desarrollo de sociedades relacionadas con el mezclado y mercadeo de fertilizantes, con el mercadeo de agroquímicos, con el manejo y almacenamiento de granos, con la extracción de aceites vegetales, y con la formulación de alimentos concentrados para animales.

Manejo de Recursos Naturales y Protección Ambiental

- Tres científicos de Rusia, Siria y Tanzanía realizaron estudios de investigación en la Sede del IFDC. El científico de Rusia llevó a cabo dos estudios para investigar (1) el efecto de la acidulación de dos rocas fosfóricas de alto contenido de cadmio en la asimilación de este elemento por el arroz de secana y (2) el efecto del tipo de cultivo (arroz anegado, caupí, soya, trigo y avena) en la asimilación de cadmio. Los tres científicos realizaron evaluaciones de la efectividad agronómica de sus respectivas rocas locales y de productos fosfatados modificados, en relación con las propiedades del suelo y especie cultivada. Un resultado significativo fue que la colza puede utilizar rocas fosfóricas en suelos neutrales y alcalinos, mientras que los otros cultivos no la pueden utilizar.
- El IFDC continuó evaluando los factores importantes que afectan el uso de roca fosfórica en la producción de cosechas. En 1997, los científicos del Centro estudiaron rocas de Argelia, Tunisia y Jordania usando arroz de secana, soya, trigo, colza, y pasto *Brachiaria decumbens*. Estas rocas fosfóricas se desempeñaron bien en suelos ácidos en comparación con fertilizantes fosfatados solubles en agua. Se inició una prueba de campo de tres años en tres provincias del sureste chino con roca de Gafsa de Tunisia bajo tres sistemas diferentes de cultivo.
- Un proyecto colaborativo con el Centro Asiático para la Investigación y el Desarrollo de Vegetales (AVRDC) entró en su tercer año en el estudio de asimilación del cadmio proveniente de fertilizantes fosfatados aplicados por diferentes vegetales en Taiwan. Muestras de plantas y suelo fueron enviadas a la Sede del IFDC para analizarles su contenido de cadmio.
- Un resultado importante de dos experimentos de invernadero indica que la roca fosfórica de grado C de la isla de Christmas, calcinada a 550 grados centígrados fue muy efectiva en el cultivo de

arroz anegado en suelos ácidos, néutros, o alcalinos. El material también mostró ser efectivo para el arroz de secana en suelos alcalinos. Hay varios millones de roca grado C arrumados en la isla como desecho. Ahora, es posible usar este material para arroz anegado, particularmente en Asia suroriental.

- En un proyecto colaborativo con el Centro Internacional de Agricultura Tropical (CIAT), un científico del IFDC estacionado en Colombia determinó los requerimientos de cal, magnesio y potasio para las variedades de arroz, maíz, caupí y soya resistentes a suelos ácidos en sistemas de producción rotacional en Oxisoles de textura media. Su investigación también mostró que el reciclo de nitrógeno, fósforo y potasio fue mayor cuando se rotaban el arroz y el maíz con legumbres, especialmente en abonos verdes, que cuando se cultivaban en monocultivos.
- Durante el primer año del "Programa Colaborativo de Investigación en la Restauración y Mantenimiento de la Fertilidad del Suelo en Areas de Escasos Recursos del Sub-Sahara Africano," el proyecto del Fondo Internacional para el Desarrollo Agrícola (FIDA) probó los efectos del mejoramiento de la fertilidad del suelo sobre la eficiencia del uso de fertilizantes en ensayos de estación. El IFDC-Africa estableció contactos para probar este concepto en 1998 en experimentos en fincas en cuatro países de Africa Occidental.
- Durante 1997, el proyecto de la Asociación Internacional de la Industria de los Fertilizantes (IFA) intitulado "Fertilizantes y Desarrollo Agrícola Sustentable en el Africa Occidental: Estrechando Enlaces Entre Agricultores, Detallistas de Fertilizantes, Trabajadores de Investigación y Extensión, y Forjadores de Políticas," progresó adecuadamente. En contraste con 1996; las lluvias de 1997 favorecieron el crecimiento del maíz en tres países participantes: Togo, Benín y Niger. En todas las aldeas aumentó el número de agricultores participantes. El IFDC-Africa inició esfuerzos para extender el proyecto en los tres países participantes y para comenzar actividades en Ghana y Malí. Esto resultará en un aumento sustancial en el número de aldeas participantes en el proyecto.

Sistemas de Manejo de Información

- Durante 1997, 86 científicos representando a 30 instituciones de la región andina se entrenaron en el uso de modelos de simulación para la toma de decisiones en la transferencia de agrotecnología (DSSAT), durante cuatro talleres de una semana realizados en Bolivia, Colombia, Ecuador y Perú.
- Se creo una red regional de científicos de instituciones de la región andina (MOS Andes) para facilitar el intercambio de metodologías para el estudio del manejo de nutrients agroecosistemas andinos.
- Se recopiló una serie de datos relacionados con descripciones físicas y químicas de perfiles de suelos, datos climatológicos diarios, y resultados históricos de experimentos de campo para calibrar y probar modelos bajo condiciones andinas.
- En colaboración con la Administración Nacional Oceánica y Atmosférica de los EE.UU. (NOAA), científicos del IFDC desarrollaron métodos para utilizar predicciones del tiempo relacionadas con la Oscilación Sur del Fenómeno de El Niño (ENSO) en los sectores agrícolas de los EE.UU., Uruguay y Brasil.
- Científicos del IFDC comenzaron el desarrollo de dos Sistemas de Información y Apoyo para Toma de Decisiones (IDSS) para el sector agrícola de Uruguay y el estado de Paraná (Brasil). Los nuevos sistemas, desarrollados en asocio con la Administración Estadounidense de la Aeronáutica y del Espacio (NASA) y NOAA, añadirá información de satélites y predicciones a largo plazo.
- En colaboración con el Instituto Nacional de Investigación Agropecuaria del Uruguay (INIA) los modeladores de cultivos del IFDC desarrollaron un modelo predictivo para estimar las tasas de descomposición de diversos resíduos de cosechas bajo condiciones con y sin labranza.
- En colaboración con el INIA del Uruguay y el Banco Mundial, científicos del IFDC establecieron en el Uruguay un programa comprensivo de investigación incluyendo pruebas de suelos, análisis de plantas, y modelos de simulación para desarrollar un sistema de recomendaciones en producción de cosechas en las pampas húmedas de Sur América.
- En colaboración con el Instituto Internacional para la Investigación de Políticas Alimenticias (IFPRI), los investigadores del IFDC conceptualizaron y desarrollaron un programa de computación

de en lace los modelos biofísicos elaborados en el IFDC y los modelos económicos elaborados en el IFPRI generando un modelo bioeconómico para usarse dentro del proyecto de Alternativas a la Tala y Quema. Los varios componentes serán enlazados en forma interactiva para reflejar el proceso decisorio de los pequeños agricultores en las márgenes forestales del Brasil.

- Como parte del proyecto del Centro Australiano para la Investigación Agrícola Internacional (ACIAR) para mejorar la eficiencia y predictabilidad de inhibidores biológicos para reducir las pérdidas de nitrógeno y acrecentar la productividad del arroz anegado, científicos del IFDC completaron modificaciones científicas del modelo CERES-Arroz para reflejar los datos recogidos en experimentos de campo. Se incorporaron en el modelo y se probaron contra datos medidos, nuevos fertilizantes que incorporan tanto ureasa como inhibidores de nitrificación.
- En colaboración con el Consorcio Internacional para la Aplicación de Sistemas Agrícolas (ICASA), los modeladores de cultivos del IFDC realizaron dos talleres de modelaje de cultivos. El primero, llevado a cabo en cooperación con el Consejo Indio de Investigación Agrícola (ICAR), se realizó en Modipuram, Uttar Pradesh, India. El segundo se realizó en la Sede del IFDC. El interés tanto internacional como doméstico por el modelaje y simulación del crecimiento de cultivos sigue fuerte.
- Científicos del IFDC colaboraron con sus contrapartes de la Universidad del Estado de Michigan para desarrollar un submodelo de fósforo para aplicaciones de modelaje. El formato modular propuesto para el submodelo de fósforo facilitará la integración de las rutinas de fósforo, incluyendo la dinámica de la roca fosfórica, dentro de todos los modelos DSSAT existentes.

Desarrollo de Capacidad Humana

- Con el patrocinio del Fondo Fiduciario Holandés para el Medio Ambiente, especialistas en fertilidad del suelo del IFDC realizaron en 1997 en Lomé, Togo, en asocio con el Banco Mundial, un Taller Internacional para Elaborar Estrategias Nacionales para la Recapitalización de la Fertilidad del Suelo en el Sub-Sahara Africano. Ciento veinte participantes de 26 países, incluyendo científicos, economistas, especialistas del medio ambiente, y oficiales de gobiernos, asistieron al taller durante el cual se elaboró un marco patrón para planes nacionales de acción para mejorar la fertilidad del suelo.
- En 1997 y en colaboración con la Universidad de Georgia, la Universidad de Florida, e ICASA, modeladores de cosechas del IFDC organizaron en la Sede un Programa de Entrenamiento sobre Simulación en Computador de Crecimiento de Cultivos y Decisiones de Manejo. Los participantes corrieron los modelos CERES, CROPGRO, SUBSTOR, CROPSIM, CANEGRO, y OILCROP, simulando el crecimiento y desarrollo de cultivos, y respuestas al agua y a nutrientes.
- Con el copatrocinio de la Asociación Europea de Productores de Fertilizantes (EFMA), IFA, el Instituto de Fertilizantes (TFI), la Organización de las Naciones Unidas para el Desarrollo Industrial (ONUDI), y el Programa de las Naciones Unidas para el Medio Ambiente (PNUMA), especialistas del medio ambiente del IFDC organizaron en Atlanta, Georgia, EE.UU., un Taller Internacional sobre Retos Ambientales de los Productores de Fertilizantes - Un Examen de Progresos y Problemas. El taller cubrió cómo la industria de fertilizantes puede resolver los retos ambientales que encara.
- En Lomé, Togo, especialistas del IFDC realizaron un Programa Internacional de Entrenamiento sobre Elaboración de Recomendaciones de Fertilizantes Basadas en Experimentos de Campo y Modelos de Cultivo-Suelo. Los participantes dicutieron estrategias relacionadas con el manejo integrado de nutrientes de plantas, el manejo de fertilizantes orgánicos y minerales, y el modelaje y la experimentación para respaldar recomendaciones para el uso eficiente de fertilizantes.
- En asocio con la Sociedad de fertilizantes de Sur Africa, el IFDC organizó y realizó un Programa Internacional de Entrenamiento sobre la Comercialización de Fertilizantes: Retos y Oportunidades. Se discutieron las técnicas y habilidades necesarias para competir en un sistema de mercado libre y abierto.
- Se realizaron programas especializados de entrenamiento en una gran variedad de temas específicos para individuos y grupos de científicos, ingenieros y especialistas de mercadeo de Albania, Argentina, Bangladesh, China, México, Paquistán, Rusia, Siria y Tanzanía.

Résumé Analytique

Le présent rapport annuel est articulé autour du thème suivant: "Des éléments nutritifs pour les plantes qui nourrissent les hommes". Les scientifiques et les spécialistes de l'agro-industrie et du développement des ressources humaines de l'IFDC s'appliquent à promouvoir une utilisation équilibrée et efficace des éléments nutritifs des plantes, d'origine tant organique qu'inorganique, pour intensifier l'agriculture de façon durable.

Les paragraphes suivants résument les activités menées par l'IFDC pendant l'année 1997 dans les domaines du développement de marché, de la gestion des ressources naturelles et de l'environnement des systèmes de gestion de l'information et du renforcement des capacités humaines.

Développement de marché

- Le Projet de développement de la technologie et des agro-industries - Agro-Based Industries and Technology Development Project (ATDP), qui a démarré au milieu de l'année 1995 au Bangladesh, est axé sur l'accroissement des emplois productifs dans le secteur agricole par la stimulation des investissements privés dans la production et la commercialisation des intrants, des produits et des technologies agricoles dans un environnement commercial ouvert et compétitif. Avec l'appui de l'Agence américaine pour le développement international (USAID), le projet intervient dans différents sous-secteurs: les semences, les cultures, les engrais, l'horticulture, l'élevage, l'aviculture, la pêche, la machinerie agricole, les équipements et l'agro-industrie.
- Depuis la création du projet ATDP, les investissements privés dans les agro-industries ont augmenté de 120 millions de dollars américains; les entrepreneurs détiennent actuellement 40% des actions de diverses entreprises commerciales.
- Grâce à l'appui de ce projet qui encourage l'utilisation de technologies améliorées et le développement de marchés pour les produits agricoles, les revenus agricoles et les possibilités d'emplois dans les zones pilotes ont largement dépassé les objectifs fixés, dans certains cas, de quatre fois les résultats attendus. Actuellement, au Bangladesh, environ 150 000 agriculteurs et employés en agro-industries ont bénéficié du projet par l'augmentation des possibilités d'emploi et l'accroissement des revenus des familles rurales.
- Avec la poursuite du projet, les enseignements dégagés et les résultats techniques et économiques obtenus dans les quatre zones pilotes devraient pouvoir s'inscrire dans la réalité globale du secteur agricole au Bangladesh.
- Les troubles politiques et économiques qu'a connu l'Albanie durant l'année 1997 ont provoqué l'arrêt de toutes les activités de développement dans le pays. Grâce à la détermination de l'USAID et de l'IFDC, le projet est resté en activité bien que le personnel expatrié ait dû être évacué. Dans ce contexte difficile, l'Albanian Fertilizer and Agricultural Inputs Dealers Association (AFADA) a pu maintenir les activités agricoles et de distribution d'engrais dans le pays avec l'assistance du projet USAID/IFDC.
- A la fin de 1997, 81,5% des agriculteurs albanais utilisaient les engrais inorganiques contre 63% en 1994. Les rendements en maïs ont grimpé atteignant 2,8 t/ha contre 1,8 t/ha en 1994, tandis que les

importations d'engrais ont augmenté de 17% par rapport aux valeurs de 1996. Des laboratoires ont été installés pour l'Institut pédologique et l'Institut national des semences.

- En dépit de la régression de l'économie au Venezuela en 1997, qui a affecté la production et les ventes de Petroquimica de Venezuela S. A. (PEQUIVEN), l'usine d'ammoniac de PEQUIVEN a été fondamentalement rénovée, ce qui lui assure un fonctionnement plus efficace et plus soutenu. Sur cette lancée, l'usine a été aussi modernisée. Ainsi, la consommation d'ammoniac par tonne d'urée a été ramenée à un niveau compatible avec les pratiques actuelles au niveau mondial. (Depuis le milieu de l'année 1994, l'IFDC aide PEQUIVEN à faire la transition entre son statut de société nationale et celui d'une entreprise axée sur le marché).
- Avec l'aide de l'IFDC, PEQUIVEN a continué à travailler sur les questions relatives à la qualité des produits (particulièrement celle de l'acide phosphorique et des composés NPK), la consommation de matières premières par unité de production, l'environnement, la sécurité et la maintenance préventive. Ces efforts ont permis une amélioration générale de la qualité des produits NPK, une utilisation plus efficace des matières premières, moins de pollution environnementale et une diminution des fermetures d'urgence.
- En tant que sous-traitant de Citizens Network for Foreign Affairs, Inc. (CNFA), l'IFDC participe à un programme de coopération de l'USAID intitulé "Programme de Partenariat en Agro-industries, Phase II pour l'Ukraine, la Moldova et Belarus: Projet de restructuration des systèmes alimentaires". Ce Programme de trois ans vise à renforcer les capacités des agro-industries privées locales qui fonctionnent avec efficacité dans les Etats occidentaux nouvellement indépendants grâce à une collaboration avec des entreprises américaines. Le financement de l'USAID joue le rôle essentiel de catalyseur en incitant des entreprises du secteur privé américain à engager des activités de développement bien ciblées visant à défaire les blocages en amont et en aval des systèmes de production alimentaire de ces pays, qui dépassent la portée de leurs activités essentielles. Les ressources engagées par l'USAID quoique modiques attirent d'importants capitaux permanents privés et permettent des avancées réelles dans le domaine de la technologie et du développement que ces pays n'auraient jamais connu. Un conseiller en agro-industries de l'IFDC détaché auprès de CNFA/Kiev travaille sur le partenariat dans le domaine du mélange et de la commercialisation des engrais, la commercialisation des produits chimiques pour l'agriculture, la manutention et le stockage des céréales, l'extraction des huiles végétales et la formulation de concentrés et d'aliments composés pour le bétail.

Gestion des ressources naturelles et protection de l'environnement

- Trois chercheurs de la Russie, de la Syrie et de la Tanzanie ont entrepris des recherches au siège de l'IFDC. Le chercheur russe a mené deux études sur: (1) l'effet de l'acidification de deux types de phosphate naturel ayant une forte teneur en cadmium sur l'absorption de cadmium du riz de montagne et (2) l'effet des espèces de céréales (riz aquatique, niébé, soja, blé et avoine) sur l'absorption de cadmium. Les trois chercheurs ont évalué l'efficacité agronomique des phosphates naturels locaux et celle des produits phosphatés enrichis sous l'effet des propriétés du sol et des espèces cultivées. L'une des importantes conclusions de leurs travaux est que le colza utilisait le phosphate naturel dans les sols neutres et alcalins tandis que les autres cultures ne pouvaient pas l'utiliser.
- L'IFDC a poursuivi l'évaluation des importants facteurs qui conditionnent l'utilisation des phosphates naturels dans la production vivrière. Durant l'année 1997, les chercheurs du Centre ont analysé les effets des phosphates naturels d'Algérie, de Tunisie et de Jordanie sur le riz de montagne, le soja, le blé, le colza et la *Brachiara decumbens* comme cultures d'essai. Sur les sols acides, ces phosphates ont donné de bons résultats en comparaison des engrais phosphatés solubles dans l'eau. Un essai agronomique de trois ans, en milieu paysan, avec le phosphate naturel de Gafsa en Tunisie, a été installé dans trois provinces du Sud-Est de la Chine avec différents systèmes culturaux.
- Le projet mis en œuvre en collaboration avec l'Asian Vegetable Research and Development Center (AVRDC) entre dans sa troisième année. Ce projet vise à évaluer l'absorption du cadmium apporté avec les engrais phosphatés par différentes cultures en Taïwan. Des échantillons de sol et de plante ont été envoyés à l'IFDC pour être analysés du point de vue de leur capacité d'absorption de cadmium.
- Deux expériences en serre ont abouti à la conclusion que le phosphate de qualité C de Christmas Island, calciné à 550 degrés était très efficace sur le riz aquatique cultivé dans des sols acides, neutres

et alcalins. Ce phosphate est également efficace sur le riz de montagne cultivé dans des sols alcalins. Plusieurs millions de tonnes de ce produit sont entassées sur l'île sous forme de déchets. Il peut servir désormais pour la production du riz aquatique, particulièrement en Asie du Sud-Est.

- Dans le cadre d'un projet mis en œuvre en collaboration avec le Centre International d'Agriculture Tropicale (CIAT), un chercheur de l'IFDC affecté en Colombie a défini les besoins en chaux, en magnésium et en potassium pour des variétés de riz, de maïs de niébé et de soja adaptées aux sols acides dans des systèmes de rotation sur les Oxisols à texture moyenne. Il a en outre quantifié l'efficacité résiduelle et les besoins en termes de chaulage d'entretien pour ces mêmes sols. Ses recherches ont aussi montré que le recyclage de l'azote, du phosphore et du potassium était plus important quand le riz était cultivé en rotation avec des légumineuses, particulièrement les engrais verts, plutôt que dans les systèmes de monoculture.
- Durant la première année du "Programme de recherche participative pour la restauration et la gestion de la fertilité des sols dans les régions démunies de l'Afrique subsaharienne", le projet du Fonds International de Développement Agricole (FIDA) a testé l'effet de l'amélioration de la fertilité du sol sur l'efficacité de l'utilisation des engrais dans les essais en station. L'IFDC-Afrique a établi des contacts en vue de tester ce concept, au cours de l'année 1998, à l'aide d'essais en milieu paysan, qui seront menés dans quatre pays ouest africains.
- Durant l'année 1997, d'importants progrès ont été enregistrés concernant le projet de l'International Fertilizer Association (IFA) intitulé "Engrais et développement agricole durable en Afrique de l'Ouest: Renforcer la collaboration entre agriculteurs, distributeurs d'engrais, chercheurs, vulgarisateurs et responsables politiques". Contrairement aux pluies de1996 celles de 1997 ont favorisé la croissance du maïs dans les trois pays participants - le Togo, le Bénin et le Niger. Dans tous les villages cibles, le nombre d'agriculteurs participant au projet a augmenté. L'IFDC-Afrique a engagé une action en vue d'élargir le projet dans les trois pays impliqués et de lancer des activités au Ghana et au Mali. Ces développements entraîneront une augmentation substantielle du nombre de villages participant au projet.

Systèmes de gestion de l'information

- Au cours de l'année 1997, quatre-vingt-six scientifiques représentant trente institutions de la région des Andes ont été formés à l'utilisation des modèles de simulation (DSSAT) au cours de quatre ateliers d'une semaine organisés en Bolivie, en Colombie, en Equateur et au Pérou.
- Un réseau régional de chercheurs des institutions andines (MOS Andes) a été créé en vue de faciliter les échanges d'informations et de méthodologies pour l'étude des questions de gestion des éléments nutritifs dans les agro-écosystèmes andins.
- Une base de données contenant des descriptions physiques et chimiques des profils de sol, des informations météorologiques et les résultats d'expériences historiques en milieu réel, a été mise sur pied pour le calibrage des modèles et leur mise à l'essai dans les conditions qui prévalent dans la région andine.
- En collaboration avec la National Oceanic and Atmospheric Administration (NOAA), des chercheurs de l'IFDC ont mis au point des méthodes permettant d'appliquer les prévisions saisonnières relatives à El Niño/Southern Oscillation (ENSO) dans le secteur agricole aux Etats-Unis, en Uruguay et au Brésil.
- Avec l'appui de la National Aeronautics and Space Administration (NASA) et la NOAA, les chercheurs de l'IFDC ont commencé à mettre au point deux nouveaux systèmes d'information et d'appui à la décision (IDSS) pour le secteur agricole en Uruguay et dans l'Etat de Parana (Brésil). Les nouveaux IDSS viendront ajouter des informations satellitaires et des prévisions saisonnières.
- En collaboration avec l'Instituto Nacional de Investigación Agropecuaria (INIA)/Uruguay, les modélistes de culture de l'IFDC ont mis au point un modèle permettant d'estimer les taux de décomposition de différents résidus de culture en conditions de labour classique ou sans labour.
- En collaboration avec l'INIA/Uruguay et la Banque mondiale, les chercheurs de l'IFDC ont établi en Uruguay un programme complet de recherches comprenant l'analyse des sols et des plantes, et des modèles de simulation dans le but de développer un système permettant de formuler des recommandations en matière de production agricole pour les Pampas humides d'Amérique du Sud.
- En collaboration avec l'Institut de recherche sur les politiques alimentaires (IFPRI), les chercheurs de l'IFDC ont conceptualisé et développé un programme informatisé liant les modèles biophysique mis au

point à l'IFDC et les modèles économiques mis au point à l'IFPRI à un modèle bio-économique qui sera utilisé dans le cadre du projet "Alternatives à la culture sur brûlis". Ces divers éléments seront liés de façon récursive pour simuler le processus de prise de décision au niveau des petits agriculteurs dans les zones limitrophes des forêts au Brésil.

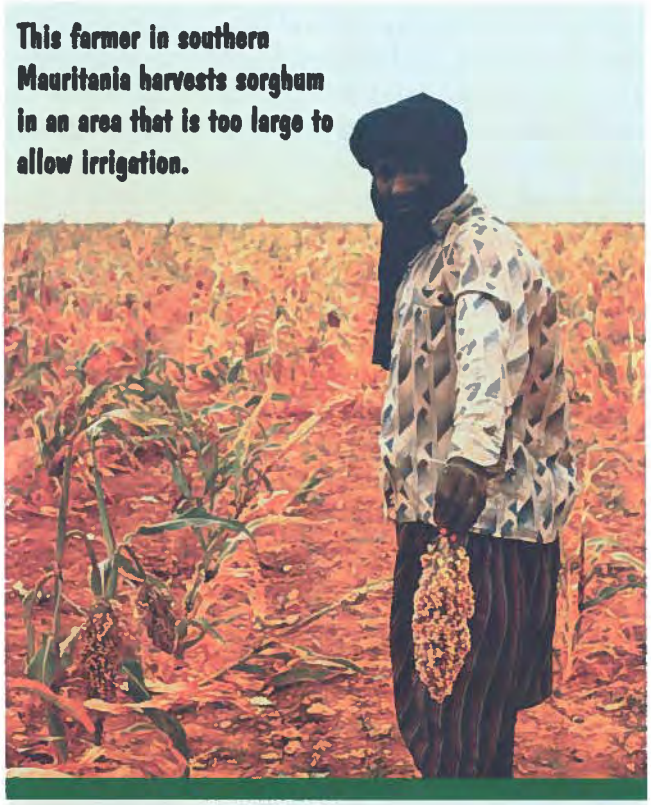
- Dans le cadre du projet de l'Australian Centre for International Agricultural Research (ACIAR) sur l'amélioration de l'efficacité et de la prévisibilité des inhibiteurs biologiques pour réduire les pertes d'azote et améliorer la productivité du riz aquatique, les chercheurs de l'IFDC ont apporté des modifications scientifiques au modèle de riz-CERES sur la base des données recueillies en milieu réel. De nouveaux types d'engrais renfermant des inhibiteurs de l'uréase et de la nitrification étaient incorporés dans le modèle et testés en comparaison des données mesurées.
- En collaboration avec l'International Consortium for Agricultural Systems Applications (ICASA), les modélistes de culture de l'IFDC ont organisé deux ateliers de modélisation. Le premier, en coopération avec l'Indian Council of Agricultural Research (ICAR), s'est tenu à Modipuram, Uttar Pradesh, Inde. Le second s'est tenu au siège de l'IFDC. L'intérêt pour la simulation en agriculture reste fort tant sur le plan intérieur que sur le plan international.
- Les chercheurs de l'IFDC ont collaboré, avec leurs partenaires de l'Université d'Etat du Michigan, à la mise au point d'un sous-modèle du phosphore révisé pour des applications en modélisation. Le format modulaire proposé vise à faciliter l'intégration des procédures du phosphore, dont la dynamique du phosphate naturel, dans tous les modèles DSSAT existants.

Développement des capacités humaines

- Avec un financement du Netherlands Environmental Trust Fund, les spécialistes de la fertilité du sol de l'IFDC, conjointement avec la Banque mondiale, ont organisé en 1997 un atelier international sur: L'élaboration de stratégies nationales de recapitalisation de la fertilité des sols en Afrique subsaharienne. Cet atelier qui s'est tenu à Lomé au Togo a réuni cent vingt chercheurs, économistes, spécialistes de l'environnement et hauts cadres nationaux de vingt-six pays. Les participants ont défini un cadre stratégique pour des plans d'actions nationaux d'amélioration de la fertilité des sols.
- En coopération avec l'Université de la Géorgie, l'Université de la Floride et l'ICASA, les modélistes de l'IFDC ont organisé au siège un programme international de formation sur: La simulation à l'ordinateur de la croissance des cultures et de leurs réponses aux pratiques de gestion. Les participants ont employé divers modèles: CERES, CROPGRO, SUBSTOR, CROPSIM, CANEGRO et OILCROP pour simuler la croissance, le développement et la réponse des cultures à l'eau et aux éléments nutritifs.
- Avec le parrainage conjoint de l'European Fertilizer Manufacturers' Association (EFMA), l'IFA, The Fertilizer Institute (TFI), l'Organisation des Nations Unies pour le Développement Industriel (ONUDI) et le Programme des Nations Unies pour l'Environnement (PNUE), les spécialistes de l'environnement de l'IFDC ont organisé à Atlanta en Géorgie (U.S.A.) un atelier international sur: Les défis environnementaux liés à la production des engrais - analyse des progrès et des limites. L'atelier a exploré les moyens de faire face aux défis environnementaux qui se posent à l'industrie des engrais.
- Les chercheurs de l'IFDC ont organisé à Lomé au Togo un programme international de formation sur: L'élaboration de recommandations basées sur les expériences en milieu réel et les modèles sol-culture. Les travaux étaient axés sur les stratégies de gestion intégrée des éléments nutritifs des plantes, la gestion des engrais organiques et minéraux, et la modélisation et l'expérimentation à l'appui des recommandations pour une utilisation efficace des engrais.
- Avec le parrainage conjoint de la Fertilizer Society of South Africa, l'IFDC a organisé à Pretoria en Afrique du Sud un programme international de formation sur: La commercialisation des engrais: défis et opportunités. La réflexion a porté sur les techniques et les aptitudes nécessaires pour être compétitif dans un marché libre et ouvert.
- Des programmes spéciaux de formation individuelle ont été organisés sur un large éventail de sujets pour des chercheurs, des ingénieurs et spécialistes de la commercialisation de divers pays dont l'Albanie, l'Argentine, le Bangladesh, la Chine, le Mexique, le Pakistan, la Russie, la Syrie et la Tanzanie.

Nutrients to Feed Plants That Nourish People: IFDC's Activities During 1997

The Food and Agriculture Organization of the United Nations (FAO) in its publication, *World Agriculture: Towards 2010*, states that two-thirds of the expected increase in crop production in the developing countries must come from yield increases on land now under cultivation. With a finite amount of cultivable land, this increase in food production can only be obtained through greater productivity per unit of land, which requires the stimulation of improved farming practices that promote crop growth. IFDC's activities that contribute to increasing the productivity of land in the developing countries are outlined in the section that follows. These activities include studies that IFDC has conducted regarding the world's soil nutrient status and the global nutrient supply/demand situation; policy changes affecting plant nutrients that have been implemented in Albania, Bangladesh, and Burkina Faso as a result of IFDC's work in those countries; and advances in nutrient research that have been realized by IFDC in Africa, Asia, Eastern Europe, and Latin America.



This farmer in southern Mauritania harvests sorghum in an area that is too large to allow irrigation.

A Mauritanian woman irrigates her vegetable crop on the desert border where irrigation is a necessity.

World Soil Nutrient Status

Overcoming problems that lead to the nutrient depletion of agricultural land requires an understanding of the interplay among ecological and socioeconomic factors affecting the management of natural resources and farming systems. IFDC is developing and improving approaches and methods to estimate nutrient depletion in agricultural areas as a means of identifying and characterizing regions where nutrient mining is increasing and becoming a significant constraint to conserve land resources and intensify agricultural production on a sustainable basis. Estimates of nutrient requirements to avoid depletion are calculated to facilitate the design and implementation of resource management strategies that can prevent land degradation, increase production,

and conserve the resource base while protecting biodiversity and the environment.

Methods and procedures to calculate nutrient flows and balances were designed as components of computer programs developed to access databases and arrive at estimates of nutrient flows and balances of soils of cropland areas. Estimates of nutrient balances and rates of the soils' nutrient depletion in cropland areas are calculated to reflect the current status of land resources, cropping practices, and agroecological circumstances such as the inherent soil characteristics and the resilience or fragility of the soils. The system uses information from secondary sources on agricultural production and areas. The database is linked to a soil fertility monitoring system to produce attribute and geographical information on agricultural land resources and nutrient balances and requirements. Examples of some of the estimates for Africa and the world are presented in Figures 1 and 2.

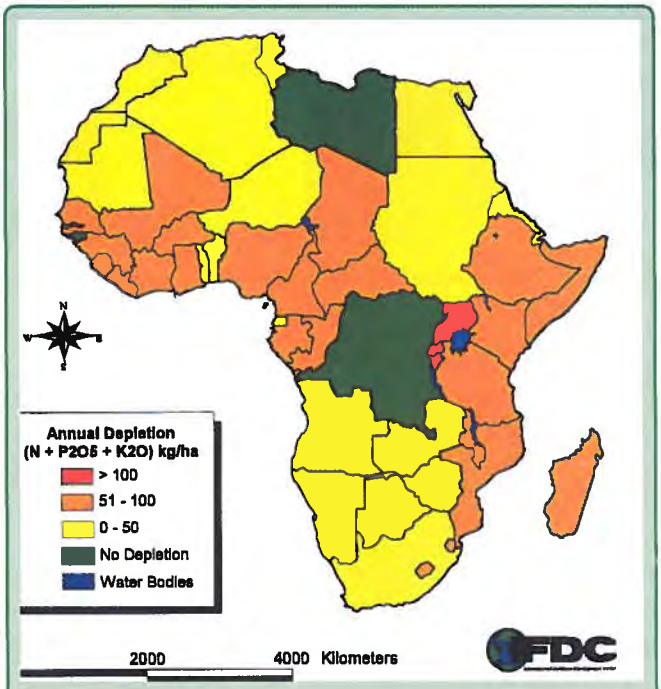


Figure 1. Average Annual Rate of Nutrient Depletion From Soils of Agricultural Lands in Africa (Years 1993-95), in kg of N + P_2O_5 + K_2O Per Hectare.

This approach represents part of a continuous effort by IFDC to improve and use methodologies to establish information management systems as part of an early warning system on soil fertility and conservation and crop production monitoring. The approach allows periodical assessment of nutrient mining and identification of agricultural areas where depletion or excessive use of nutrients affects crop production, degrades agricultural land, and may cause environmental damage. An additional benefit of this work is the dissemination of information to identify areas, countries, and regions where policy interventions are needed to prevent the

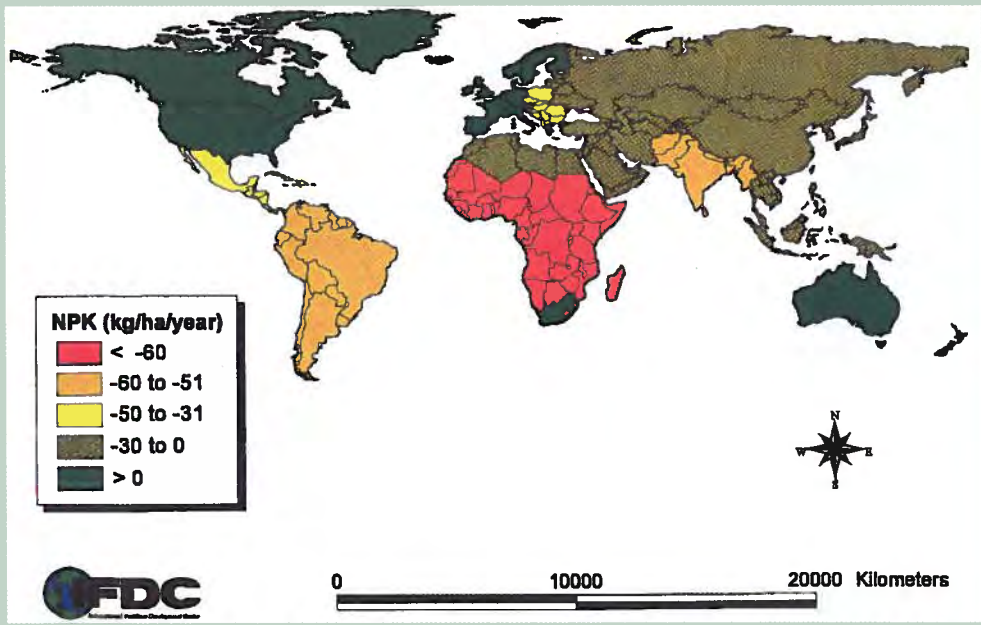


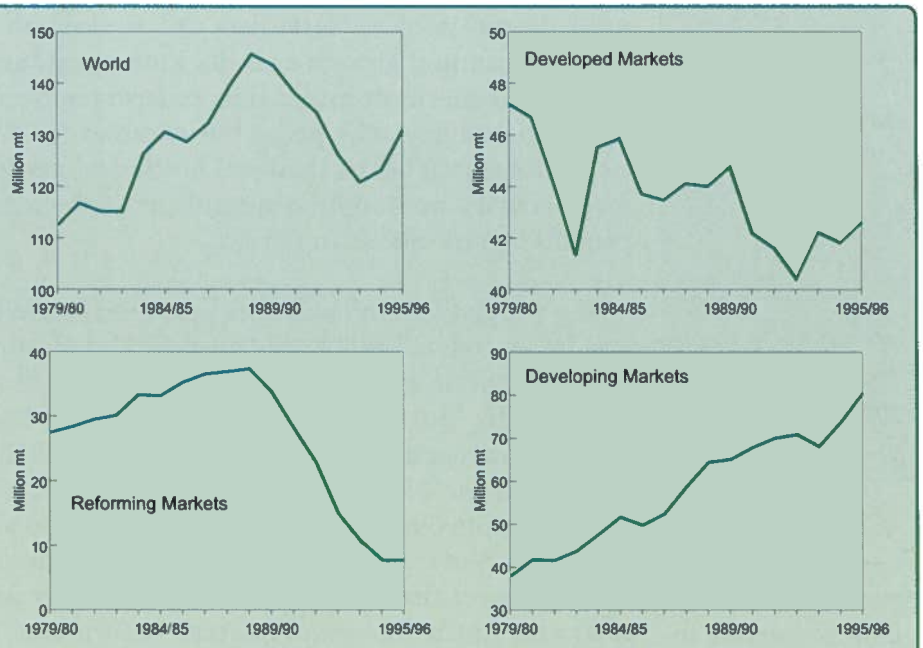
Figure 2. Regional Assessment of Average Annual Nutrient Balances in Soils of Agricultural Lands (Years 1993-95).

tremendous damage that the continuous depletion of nutrients can cause to the environment and the resource base for agriculture.

World Nutrient Supply/Demand Situation

The sustainable replenishment of nutrients removed through crop harvesting and grazing of lands by animals is essential to feed the growing population and sustain the natural resource base (soils, forests, and biodiversity). In open agroecosystems, natural sources of nutrient supply are inadequate to replenish removed nutrients and sustain soil fertility in the long run. Nutrient supply from external sources, especially in the form of mineral fertilizers, is essential. This partially explains the growth in use of mineral fertilizers from 64 million nutrient tons (mnt) in 1969/70 to 146 mnt in 1988/89 at the global level. After 1988/89, global fertilizer use decreased continuously until 1993/94 when it reached 120.8 mnt (Figure 3).

Between 1988/89 and 1993/94, global fertilizer use decreased by 24.8 mnt or 17%. A large part of this decrease was caused by political and economic reforms in Eastern Europe and Eurasia (Table 1). Both the nature and scope of economic reforms and the manner in which these reforms were introduced contributed to a drastic reduction in fertilizer use. The devaluation of domestic currency and removal of subsidies led to large increases in fertilizer prices. The sudden withdrawal of the government from fertilizer marketing and distribution made the situation worse. The disintegration of the U.S.S.R. created fragmented and dysfunctional fertilizer markets. The lack of management skills and credit for dealers and farmers and underdeveloped crop markets have kept recovery in fertilizer use slow or minimal. During the first 5 years of economic and political reforms, the size of the domestic fertilizer market was reduced by over 70% in Eastern Europe and Eurasia. The decline in fertilizer use in these regions was so great that it overwhelmed the more than 20% growth in fertilizer use in Asia and induced a downward trend in global fertilizer use during the 1988/89-1993/94 period. In addition, decline in fertilizer use in Western Europe and near stagnation in fertilizer use in Latin America also contributed to a decrease in global fertilizer use. Macroeconomic instability in Latin America and reforms of common agricultural policy (reduced support for commodity programs) in Western Europe were other important policy measures that affected fertilizer use adversely in the 1990s.



Source: Derived from FAO (1996) data.

Figure 3. Global Fertilizer Use (Nutrients) by Markets, 1979/80 – 1995/96.

After 1993/94, global fertilizer use increased due to recovery in Eastern Europe and growth in Asia, Latin America, and North America.

Future Outlook: Supply/Demand Balances – According to the FAO/UNIDO/World Bank/Industry Fertilizer Working Group (FWG), global fertilizer demand is projected to increase by 2.3%/year – from 130.9 mnt in 1995/96 to

Table 1. World: Fertilizer Use by Regions, 1988/89, 1995/96, and 2001/02

Region/Market	1988/89	1995/96	2001/02 (Projections)
	- - - -(million nutrient tons) - - -		
Developed Markets			
North America	19.9	22.5	24.3
Western Europe	22.4	17.8	16.8
Oceania	1.7	2.4	3.0
Reforming Markets			
Eastern Europe	10.1	3.3[a]	4.6
Eurasia	27.2	4.4	5.7
Developing Markets			
Africa			
North	1.7	1.7	2.1
Sub-Saharan	1.2	1.1	1.5
South	0.8	0.7	1.0
Latin America			
Central	3.0	2.1	3.0
South	5.8	6.6	9.0
Asia			
East	34.0	46.2	50.1
South	14.0	18.0	23.8
West	3.9	4.0	5.1
	51.9	68.1	79.0
World	**145.6**	**130.9[b]**	**150.0**

a. In 1993/94, 3.1 million nutrient tons.
b. In 1993/94, 120.8 million nutrient tons.
Note: Totals may not add due to rounding.
Source: FAO (1996).

150.0 mnt in 2001/02. At the regional and subregional levels, fertilizer demand is projected to increase by 1.3%/year in North America to 5.9%/year in Central America and South Africa. In Western Europe, fertilizer demand is projected to decrease by 1%/year. Both environmental concerns and reform of agricultural support programs are expected to have a negative impact on fertilizer use in Western Europe. In absolute amounts, all regions, except Western Europe and Asia, are expected to increase fertilizer demand by 1-3 mnt. In Western Europe, fertilizer use is projected to decrease by 1 mnt, whereas in Asia fertilizer demand is projected to increase by 11 mnt. Thus, Asia alone will contribute approximately 58% to the projected increase of 19 mnt at the global level. In addition to Asia's dominant position, several other features of these demand projections are noteworthy. First, reforming markets are expected to recover growth in fertilizer demand at 5%-6%/year. Second, North America and Oceania are expected to increase fertilizer use in response to growing grain exports resulting from liberalization of trade and increasing food demand. Third, Latin America is projected to experience a 5+% annual growth in fertilizer use. This is a reflection of the likely benefits that Latin America will reap from the liberalization of agricultural trade under the Uruguay Round. The main stimulus for this growth is expected to come from the export of agricultural products, such as soybean, coffee, wheat, maize, sugar, fruits, and vegetables. However, it must be mentioned that Latin America may register wide annual fluctuations in fertilizer use around this projected annual growth as it did in the past, due to external shocks or internal macroeconomic and policy instability. The projected demand for Africa will remain below the level needed to ensure food security and environmental protection, especially in sub-Saharan Africa.

The supply/demand balances prepared by FWG are presented in Table 2. At the global level, supply potential is expected to exceed the projected demand by 3-6 mnt for all three nutrients, namely, nitrogen, phosphate, and potash. At the regional level, North America and Eurasia will have a surplus and Asia will have a deficit in all three nutrients. However, West Asia will have a surplus in all three nutrients. Africa (North Africa) and Latin America (Central America) will be significant exporters of phosphate and nitrogen fertilizers, respectively. East Asia, Oceania, South Asia, South America, and sub-Saharan Africa will have a deficit in all nutrients and continue to depend on imports. Western Europe will export potash and import nitrogen and phosphate, whereas

Table 2. World: Nitrogen Supply/ Demand Balances, 2002

Region/Market	Nitrogen (N) S	Nitrogen (N) D	Nitrogen (N) B	Phosphate (P_2O_5) S	Phosphate (P_2O_5) D	Phosphate (P_2O_5) B	Potash (K_2O) S	Potash (K_2O) D	Potash (K_2O) B
	(million nutrient tons)								
Developed Markets									
North America	15.2	13.7	1.5	11.4	5.1	6.4	12.6	5.5	7.1
Western Europe	7.4	9.3	(1.9)	1.6	3.4	(1.8)	5.1	4.1	1.0
Oceania	0.3	1.1	(0.8)	0.6	1.5	(0.9)	0.0	0.4	(0.4)
Reforming Markets									
Eastern Europe	4.6	2.7	1.9	1.6	0.9	0.7	0.0	(1.0)	(1.0)
Eurasia	11.9	3.5	8.4	2.9	1.0	1.9	6.1	1.2	4.9
Developing Markets									
Africa									
North	1.8	1.3	0.5	5.8	0.5	5.3	0.0	0.2	(0.2)
Sub-Saharan	0.6	1.0	(0.4)	0.4	0.5	(0.1)	0.0	0.3	(0.3)
South	0.4	0.5	(0.1)	0.8	0.3	0.5	0.0	0.2	(0.2)
Latin America									
Central	4.4	2.0	2.4	0.9	0.7	0.2	0.0	0.4	(0.4)
South	2.8	3.3	(0.5)	1.5	3.0	(1.5)	0.7	2.8	(2.1)
Asia									
East	23.4	31.0	(7.6)	7.5	13.1	(5.6)	0.3	6.0	(5.7)
South	16.1	16.8	(0.7)	2.7	5.1	(2.4)	0.0	2.0	(2.0)
West	6.5	3.0	3.5	2.4	1.9	0.5	2.7	0.2	2.5
	46.0	50.8	(4.8)	12.6	20.0	(7.4)	3.1	8.2	(5.2)
World	**95.5**	**89.2**	**6.3**	**40.0**	**36.8**	**3.2**	**27.6**	**24.1**	**3.5**

Notes: Totals may not add due to rounding.
S = supply potential; D = projected demand; B = balance (supply-demand); ( ) = deficit.

Source: The FAO/UNIDO/World Bank/Industry Working Group on Fertilizers Annual Meeting, June 1997, and IFDC (unpublished data).

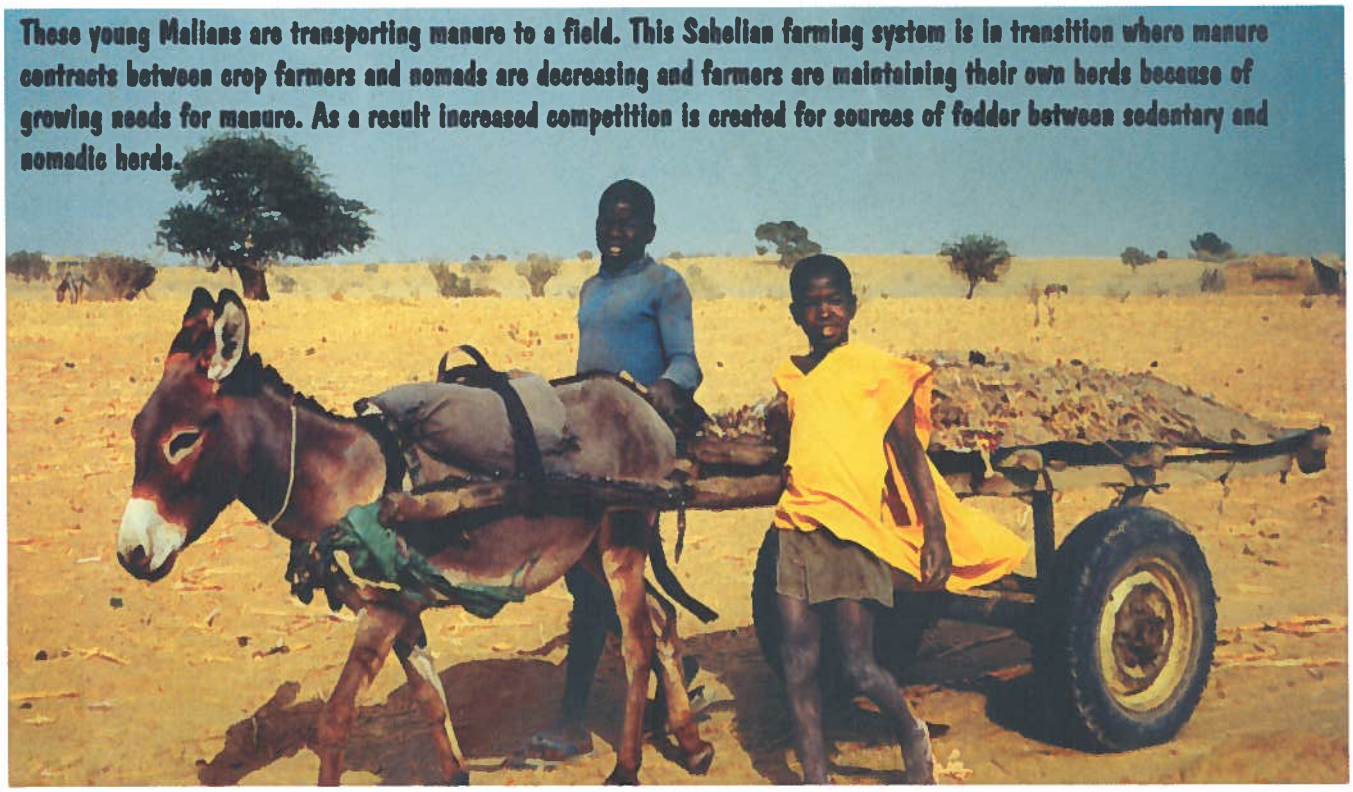
Eastern Europe will export nitrogen and import the other two primary nutrients.

Policy Changes Affecting Plant Nutrients

IFDC has designed and implemented policies that promote transparency, competition, and efficiency in the market for fertilizers and other agri-inputs in countries of Eastern Europe (Albania), Asia (Bangladesh), and Africa (Burkina Faso). Policy reform and capacity building, implemented in some countries with IFDC's assistance, have been instrumental in facilitating the timely availability and use of fertilizers and other agri-inputs in sufficient quantities and at the lowest possible costs. Increased efficiency in fertilizer supply to farmers has reduced fertilizer costs and improved the profitability of fertilizer use for farmers in these countries.

Burkina Faso – National Strategy for Soil Fertility Improvement in Burkina Faso Adopted by Government – One of the objectives of the Sustainable Agricultural Production and Market Development Project, financed by the Government of the Netherlands, is to elaborate a national strategy for soil fertility improvement in Burkina Faso. After a series of activities including sensitization of stakeholders on the need for soil fertility improvement, a national strategy was developed and adopted by the Government of Burkina Faso. The strategy provides a vision (expected status) of the soils in Burkina Faso by the year 2010 as follows:

- Soil and wind erosion losses to be minimized from current levels of 10-15 tons/ha/year to about 5-10 tons/ha/year in year 2010;
- Correction of nitrogen and phosphorus deficiencies on most of the agricultural lands by year 2010;
- Correction of deficiencies of primary nutrients by year 2010 on pastoral areas where anti-erosion structures have been installed;



These young Malians are transporting manure to a field. This Sahelian farming system is in transition where manure contracts between crop farmers and nomads are decreasing and farmers are maintaining their own herds because of growing needs for manure. As a result increased competition is created for sources of fodder between sedentary and nomadic herds.

- Improvement of the organic matter status of the soils from current levels of 0.6%-0.8% to about 1.0 % by year 2010;
- A break from an agriculture based on nutrient mining (soil nutrients are "mined" without adequate replacement) toward an agriculture based on the use of external inputs. Fertilizer consumption is thus envisaged to rise from current levels of 7.5 kg/ha to 25 kg/ha by year 2010.

The strategy then defines three action plans for its operation to restore the productive status of the soils by year 2010. These plans focus on the following: (1) the promotion of soil amendments, (2) the advancement of technologies that accompany soil amendments, and (3) the development of input and product markets.

Each of the three action plans has well-defined monitoring and evaluation systems to enable an assessment, by the year 2010, of the impacts of these activities at various levels. At the farm level, the impacts of soil fertility improvement on land productivity (e.g., increased biomass and animal production, etc.) will be evaluated. The off-farm impacts on poverty alleviation, increased food security, the rate of rural-to-urban migration, and improvement of the well-being of producers, input suppliers and processors, particularly women and other socially disadvantaged groups, will be evaluated. The extent to which soil fertility improvement reduces environmental degradation and use of marginal lands will also be assessed.

For the successful implementation of the action plans on which the strategy is based, emphasis is placed on the conscious and responsible participation of all stakeholders – producers, the private sector, nongovernment organizations, the international community, and the government.

Policy Changes Implemented in Albania – Since the beginning of IFDC's Albanian project in 1991, reform of government policies and procedures has been crucial to the success of the effort. The most notable achievements in this area, involving collaboration with the Albanian Government, were liberalizing fertilizer policy, decreasing the customs tax on fertilizer imports from 13% to 5%, and removing the 15% turnover tax on fertilizer. IFDC and AFADA have encouraged the government agencies to implement these changes in policy that have benefited the agriculture sector.

Policy Changes Implemented in Bangladesh – ATDP measures the progress of policy reform through its policy matrix. The policy matrix is based on policy issues identified by private sector entrepreneurs, public officials, professional consultants, and ATDP staff. During 1997 ATDP made efforts to effect policy reforms that would create a more congenial environment for agrobased businesses. One objective was to reduce government controls, which would improve issues related to agribusiness development in Bangladesh. ATDP's most significant policy achievements of 1997 included:

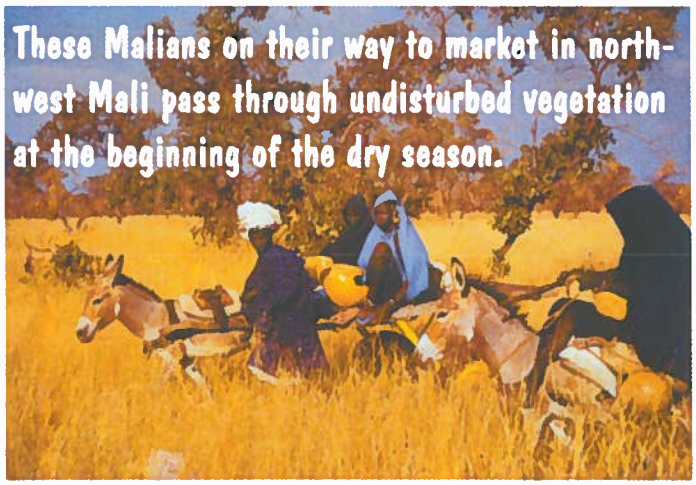
- Enactment of the Seed (Amendment) Act 1997, which simplified the registration and certification process for the five notified – strongly regulated – crops (rice, wheat, sugar, jute, and potato).
- Fertilizer subsidies on domestic urea, triple superphosphate and single superphosphate were reduced as of June 3.
- Increased air cargo space for perishable export items was secured from Bangladesh's Biman Airlines, and operation of private air cargo lines was approved.
- Policies were adopted to eliminate the indiscriminate collection of shrimp fries, a practice which leads to destruction of other aquatic species.
- Policies were adopted that give priority to fishermen and aquaculturists for leasing abandoned government-owned water bodies.

Advances in Nutrient Research and Policy Reform

Significant advances in nutrient research and policy reform are required if the burgeoning population of the developing world is to feed itself. IFDC is focusing on a range of interdisciplinary approaches in Africa, Asia, Eastern Europe, and Latin America. The pages that follow outline the specific activities undertaken by IFDC during 1997 in Albania, Bangladesh, Burkina Faso, Colombia, Ghana, Peru, Philippines, Togo, Uruguay, and Vietnam.

Africa – Developing a Framework for Soil Fertility Improvement Action Plans in Africa – With funding from the Netherlands Environmental Trust Fund, IFDC and the World Bank organized and conducted an international workshop focused on soil fertility issues in sub-Saharan Africa in Lomé, Togo, during April 22-25, 1997. The theme of the workshop was "Development of National Strategies for Soil Fertility Recapitalization in sub-Saharan Africa (including the Use of Phosphate Rock and Other Amendments)." Approximately 120 delegates attended the workshop including representatives of 21 African nations, subregional institutions, development partners, and the international agricultural research centers. The participants provided a balanced representation of important stakeholders including farmers; policy makers; economic specialists; and representatives of nongovernment organizations (NGOs), private sector-agribusiness, and public agricultural services.

The workshop objective was to develop a "blueprint" of a strategic framework for national soil fertility action plans. Based on the expertise and background of the participants, four working groups were formed: farmers and NGOs, private sector/agribusiness, policy and economic specialists, and public agricultural services. Each working group discussed three subject areas: (1) assessment of demand and planning strategy for soil fertility improvement; (2) constraints to implement technological options; and (3) necessary institutional arrangements. These discussions provided the basis for developing the "blueprint" framework and were alternated with



These Malians on their way to market in northwest Mali pass through undisturbed vegetation at the beginning of the dry season.

plenary sessions where a synthesis from each of the working group sessions was presented and discussed.

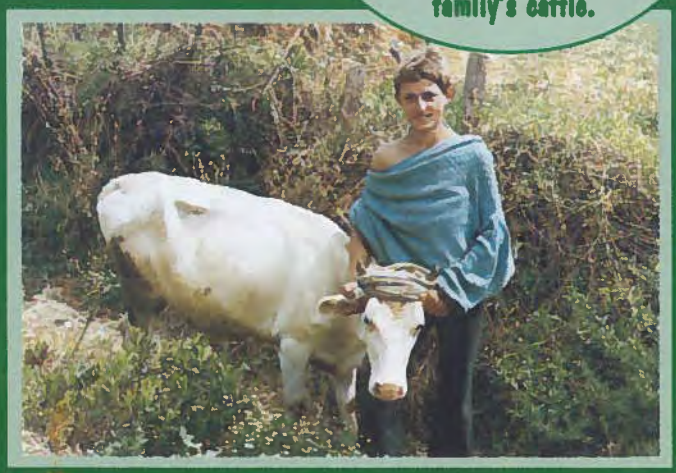
The working groups were then organized to include representatives of all groups for the final working session, which focused on the "Framework for a National Soil Fertility Improvement Action Plan." Following this session, a preliminary synthesis of the "blueprint framework" was presented to the delegates for approval. A final version of the "Framework" was approved in June 1997 by representatives of the delegates before being distributed to all workshop delegates and other interested parties.

The "Framework" outlines the necessary components – including approach, data requirements, implementation and monitoring – required to develop a systematic approach to improving soil fertility on a national level. The "Framework" was developed on the premise that soil fertility recapitalization and improvement is a prerequisite to improved efficiency of agricultural inputs (labor, organic and inorganic fertilizers, hybrid seeds, etc.), higher productivity, and competitivity. By November 1997, IFDC-Africa had participated in elaborating national plans for Burkina Faso and Ghana. In addition, requests to provide assistance in elaboration of national plans had been received from approximately ten other countries in sub-Saharan Africa. Both situations suggest that governments agree with the premise and recognize that improved soils can help trigger rural and national economic development.

Albania – Disorder, chaos, violence, and the total collapse of all state institutions characterized Albania during 1997. With such a backdrop, the achievements and successes of IFDC are even more remarkable. Despite an emergency evacuation of American citizens ordered by the U.S. Embassy in March and the resulting absence of most expatriate consultants for over 6 months of the

The embodiment of the free market system in Albania, this elderly lady offers the products of her farm for sale to her countrymen.

Young Albanians must accept some of the burden of making a living for their families; this young boy is responsible for caring for his family's cattle.



year, the project and the institutions created in previous years managed to achieve the following:

- Fertilizer use in Albania has grown steadily as a result of IFDC/AFADA activity. During 1994 63% of the farmers used inorganic fertilizers. At the end of 1997, fertilizer users accounted for 81.5% of all Albanian farmers.
- Thanks in part to the introduction of improved wheat seed varieties by IFDC/AFADA, wheat yields increased from 2.4 mt/ha in 1996 to 2.9 mt/ha in 1997. Maize yields increased from 1.8 mt/ha in 1994 to 2.9 mt/ha in 1997. Progressive farmers increased wheat yields an average of 2.3-4.3 mt/ha.
- Total production of wheat, maize, and white beans increased in 1997 to 480,000 tons, compared with 467,000 tons in 1996.
- Due in part to AFADA's lobbying efforts, the government of Albania reduced the customs tax on a total of 11 key agricultural inputs from an average of 13% to just 5%.
- AFADA increased the use of certified seed – from 600 mt in 1996 to 4,000 mt in 1997, with 6,500 mt estimated for 1998, of which 3,500 mt will be produced locally.
- The import and safe use of crop protection chemicals (CPCs) increased 258% in 1996/97. IFDC provided education on the proper environmental and safety handling of CPCs through a national television and radio campaign.
- IFDC was primarily responsible for the refurbishing and provision of equipment for laboratories of both the Soil Science Institute and the National Seed Institute of Albania, also containing a germplasm conservation unit (designed with the assistance of Mississippi State University). IFDC was instrumental in developing business plans for both laboratories, thus increasing autonomy and chances for sustainability.
- At the European Symposium on Agricultural Extension, IFDC/Albania made a presentation on AFADA as a viable private sector extension system (PSES).
- Despite the extraordinarily difficult circumstances in Albania during the spring of 1997, AFADA dealers imported 17% more fertilizer during the crisis period compared with the previous year. Fertilizer came before food aid.
- AFADA Special Publications produced a total of 16 technical manuals, pamphlets, and educational brochures, including titles such as "Fertilizer Usage," "Farm Management Studies of Albania's Mixed Farming Systems," "Fertilizer and CPC Utilization Calendars," "Vegetable Production Technology," "Computer Simulation Models Applied in Albania," "Technical Aspects of Seed Production," "Technology Transfer to Farmers," "Barley Production," and "CPC Utilization: Safety and the Environment."
- The AFADA association purchased an office and vehicle during the year and approved Standard Operating Procedures, a business plan, fees, and dues as it continued to prepare for self-sustainability.
- AFADA held its 5th annual meeting and conducted democratic elections for national and regional officers.
- IFDC further developed the AFADA Affiliate Development Center (AADC), which assisted 10 affiliate associations in registering with relevant government bodies. Five of the associations represent the primary agriculture sectors.
- During a time in which state banks ceased offering commercial credit and practically collapsed, AFADA importers secured approval from the Albanian American Enterprise Fund for a revolving line of credit in the amount of US $1.2 million.

Bangladesh – Improved Rice Cultivation in Bangladesh Using Urea Supergranule Technology – With the support of the ATDP Project, managed by IFDC, efforts in recent years to improve rice cultivation in Bangladesh using urea supergranule (USG) technology have been highly successful and represent a model of public-private sector cooperation, which is resulting in benefits for the nation's farmers and agribusiness economy.

Rice is the most important field crop in Bangladesh. Nitrogen is the key nutrient in rice production, and urea is the primary nitrogenous fertilizer used. However, urea is costly and some 70% is wasted because of the commonly used application technique of broadcasting the fertilizer in prilled form.

Urea supergranule deep placement technology is a far more efficient and cost-effective

USAID officials visit Bangladesh to review progress on the ATDP project. Pictured from left are: Kim Holtzman, wife of the U.S. Ambassador to Bangladesh; Ishrat Jahan, ATDP/IFDC; Dr. M. Hassanullah, ATDP/IFDC; Kelly C. Kamerrer, Assistant Administrator, USAID; Dr. Ronald P. Black, Chief of Party, ATDP/IFDC; David Sprague, USAID/Dhaka; Dr. Nazir Ahmed, ATDP/IFDC; and Richard M. Brown, Mission Director, USAID/Dhaka.

Khulna is one of the more important transshipment points for fertilizer in Bangladesh.

alternative. This technology involves briquetting prilled urea into one-gram granules and then deep placing these granules at a depth of 5-7 cm at rice transplantation. The use of USG deep placement technology results in substantial urea savings and rice yield increases. The quantity of urea required is reduced by some 35%, and paddy yield is increased by 20%-25%.

With the cooperation of a private entrepreneur and the Government of Bangladesh, ATDP introduced USG technology in Bangladesh in a commercial context in 1995. Since USG demonstration programs have been conducted in various regions of the country in cooperation with the Department of Agricultural Extension of the Ministry of Agriculture and the Bangladesh Rural Advancement Committee (BRAC), a major non-government organization (NGO), the Bangladesh Agricultural Research Council (BARC) has been instrumental in introducing and promoting USG technology. Several research institutes, including the Bangladesh Rice Research Institute (BRRI) and the Bangladesh Agricultural Research Institute (BARI), have incorporated USG research into their programs.

IFDC has supported the development of USG manufacture in Bangladesh by assisting machine shops in the design and production of low-cost USG briquetting machines and by assisting entrepreneurs in the establishment of businesses for USG production and marketing. At ATDP's suggestion, the Ministry of Agriculture has initiated two policies to support the development of USG manufacture and distribution; these policies have greatly contributed to the commercial success of USG. The policies were (1) to provide allotments of urea from factories to USG manufacturers at factory prices and (2) to allow free movement of USG to markets anywhere in the country. Before these two policy decisions were made, only government-appointed dealers were able to lift fertilizer from factories and the urea lifted had to be sold in a restricted geographical area.

Hundreds of thousands of farmers in Bangladesh have now been introduced to USG technology through a combination of demonstrations, field days, training, and the dissemination of informative leaflets. The area of land under USG technology has expanded from 2 ha in 1996 to 600 ha in 1997, and over 10,000 ha in 1998. From a random sample conducted this year in five districts of 159 USG-fertilized plots and 154 control plots (in which prilled urea was broadcast in split applications), paddy yields were 27% greater in the plots where USG was applied. Farmers using USG realized 57% greater profits and a 30%-35% saving of urea fertilizer. Other studies have found similar positive results.

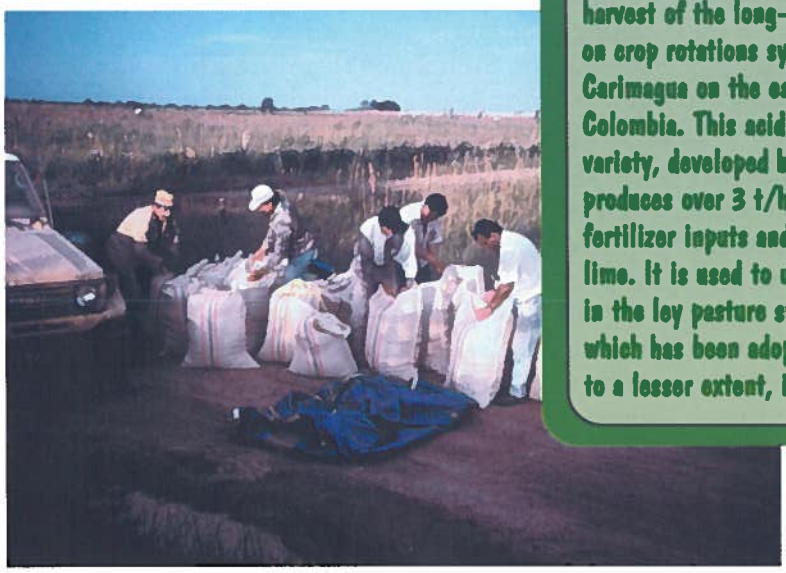
In 1998 thus far, the use of USG technology in Bangladesh has resulted in a contribution to the

employment of 271 person years and a contribution to the Gross Domestic Product (GDP) of US $1.94 million. The goal for 1999 of 100,000 ha of paddy fertilized with USG should be achievable. This will represent the third consecutive year in which the accomplishments will have increased by a factor of ten. The following benefits should also be realized in 1999: (1) a contribution to employment of 2,667 person years and (2) a contribution to the GDP of US $19.1 million. The goal for the year 2000 is to exceed all 1999 targets by yet another factor of ten.

To ensure that these goals are realized, research is being conducted in several areas. Preliminary test results of hybrids with USG have shown average yield increases (over high-yielding varieties) of approximately 50%. In cooperation with Mark Industries (a private sector entrepreneur), a machine to manufacture megagranules (approximately 2.6 g each) has been developed and is being commercialized to simplify the deep placement procedure. The improved procedure will require the use of only one granule at a time rather than three. ATDP is also cooperating with several private companies in the development of a USG applicator, which if successful will further simplify the deep placement procedure. Finally, research is being conducted on multinutrient granules; balanced doses of nitrogen and other nutrients are being used. Such granules could produce huge yield increases of hybrid varieties of rice.

In summary, the agronomic efficiency of USG and its positive impact on urea saving, employment generation and increased economic returns from paddy production provide a promising basis for large-scale expansion of paddy cultivation using USG technology in Bangladesh.

Colombia – Improving Nutrient Management on Colombian Savannas – In collaboration with CIAT, IFDC has conducted for the past 5 years a long-term crop rotation and ley pasture systems experiment on the Colombian savannas. The main goal of this experiment is the development of efficient, productive, and sustainable systems for the highly acidic, infertile soils that dominate this ecosystem and occupy some 260 million ha of the South American continent. A central hypothesis to IFDC's work in this project is that nutrient cycling is improved in systems that incorporate components that are more efficient in nutrient acquisition than others. That is, efficient nutrient acquirers cycle nutrients to less-efficient components in the system. To examine this hypothesis, we have estimated and compared the uptake and recycling of macronutrients (nitrogen [N], phosphorus [P], and potassium [K]) in rice and maize monocultures and rotations with grain legumes or green manures since the experiment was established in 1993 on an Oxisol removed from native savanna grassland. All crops in these systems received adequate and constant nutrient applications every year.



Workers bag upland rice from the harvest of the long-term experiment on crop rotations systems at Carimagua on the eastern plains of Colombia. This acid soil-tolerant variety, developed by CIAT breeders, produces over 3 t/ha with modest fertilizer inputs and fertilizer rates of lime. It is used to undersow pastures in the ley pasture system technology, which has been adopted in Brazil and, to a lesser extent, in Colombia.

We have found that systems that included a rotation of a legume crop or green manure following the cereal crop resulted in greatly enhanced total nutrient uptake. In relation to biomass production, legumes were considerably more efficient in acquiring nutrients than cereals. However, the higher returns of biomass and nutrients in the rotational systems did not produce

marked effects in succeeding cereal grain yields. Although all acquired nutrients from legume green manures were returned to the soil, available nutrient pools other than N did not reflect the inputs of recycled nutrients.

Biological N_2 fixation considerably augmented biomass N inputs in rotations and contributed to increased available (mineral) soil N levels. Uptake and recycling of N in rotations approached or exceeded the levels of N applied in fertilizer although studies by IFDC and CIAT scientists using ^{15}N tracers indicated that recovery of fertilizer-derived N by the crop was greater than that of N derived from green manures. Fertilizer N applications and recycled N derived from legumes resulted in large accumulations of mineral N in the soil profiles beneath these systems. A considerable proportion of this N was found at depths greater than 40 cm where it may be inaccessible to other crops growing in the sequence, especially more acid soil-sensitive germplasm.

Acquisition and recycling of K were also high in relation to K inputs from fertilizer. Legumes, especially cowpeas, were particularly efficient in acquiring K and recycling it back to the soil. In rotational systems, K uptake generally exceeded K applied from fertilizer, despite the initially low level of exchangeable K in the soil. Considering the weak growth response to K applications, these observations are consistent with the presence of small amounts of K-fixing aluminum (Al)-interlayer vermiculite clays in these Oxisols, both of which reduce fertilizer requirements and losses by leaching. The availability of this K is underestimated by the current soil test methods used on these soils.

In comparison to fertilizer inputs, acquisition and recycling of P (in contrast to N and K) were very low in all systems. P recovery was generally less than about 25% of P applied. Among the component crops, cowpea was most effective at recycling P although (as with K) increased P returns in residues/green manure litter had no measurable impact on available P measured by the Bray-2 method, the current standard P soil test. In general, the very poor recovery of P from soil indicates considerable scope to improve the efficiency of P inputs on high P-sorbing soils. Differences among crop species in the systems studied here indicate that there is potential to improve P acquisition in systems, which is an essential first step to improved P cycling.

The long-term systems experiment incorporated new crop cultivars that are comparatively more or less adapted to the edaphic constraints of highly infertile and acidic Oxisols. Among these different crop components, varying degrees of tolerance to the severely acid soil conditions (85%-90% Al saturation) were displayed. Rice and cowpea varieties only responded to "fertilizer" lime rates up to 150 kg/ha while acid-soil tolerant maize and soybean lines required substantial lime amendments (of soil pH and exchangeable Al saturation) to realize their full yield potential.

At two sites we studied the dynamics of lime and nutrient cations (calcium [Ca], magnesium [Mg], and K) under "fertilizer" lime rates and moderate lime amendments in the rice-cowpea and maize-soybean rotational systems to establish balanced nutrient requirements for more efficient use of inputs and to quantify interactions that may affect nutrient fluxes and improve nutrient use efficiency. Deficiencies of Mg or K were not induced or exacerbated by increasing levels of lime, as might be expected with a severe nutrient imbalance although retention of Mg and K on soil cation exchange sites was improved. Liming effects were immediate (within one season of application) but commenced to diminish almost immediately, especially at the low ("fertilizer") application rates. Higher lime applications maintained low exchangeable Al and high exchangeable Ca for longer periods of time as coarser particles continued to react and dissolve under the acidifying conditions of cultivation, N fertilization, and green manure/legume residue incorporation.

Peru – Adopting a Systems Approach to Nutrient Research in the Andean Region – Andean agriculture is strongly influenced by differences not only in altitude, climate, and soil but also by differences in culture and access to credit and markets. To understand better how these differences impact on the sustainability of agricultural systems, an innovative regional consortium

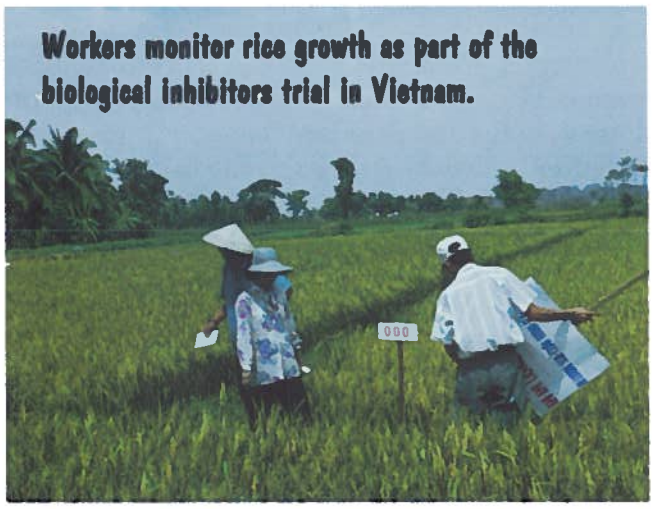
of scientists, policy makers, and development specialists was formed in 1992. This consortium, referred to as CONDESAN – Consortium for the Sustainable Development of the Andean Ecoregion – with more than 90 institutions as members, has a wide range of research and development projects underway at benchmark sites in Bolivia, Colombia, Ecuador, Peru, and Venezuela. Among these are two separately funded research projects addressing unresolved methodological problems related to the integrated assessment of economic, agricultural, and environmental issues in an ecoregional context. One project has the goal of developing decision support tools for analyzing economic and environmental tradeoffs in agriculture (Ecuador and Peru), whereas the other is developing and testing methods for integrating remote sensing, geographic information systems (GIS), and dynamic models for monitoring land use in the Altiplano (Bolivia and Peru). Both projects are interdisciplinary and have a regional focus on high Andean agro-ecosystems. An IFDC systems modeling scientist posted at the International Potato Center (CIP) has worked with a CONDESAN team in securing funds for these projects and has been active in their implementation during 1997. Funding for these projects is being provided by the USAID Soil-Management Collaborative Research Support Program (CRSP) and the Ecoregional Fund to Support Methodological Initiatives, managed by the International Service for National Agricultural Research (ISNAR).

The tradeoffs project is being conducted at two CONDESAN benchmark sites in northern Peru and Ecuador. A systems research approach is being used to link economic decision making models, biophysical models, and GIS into a Decision Support System (DSS). The economic model is designed to capture changing priorities in farm households and communities; the biophysical model simulates plant growth and soil-related processes. GIS is needed to analyze spatial and temporal variability at different levels of aggregation. An important analytical product of the DSS is the capability of quantifying tradeoff curves that define the relationship between indicators tied to agricultural production and impacts on the environment. The indicators chosen are those thought to be most important in determining the sustainability of the system. For instance, the indicators initially selected for consideration include the value of agricultural output; water quality; attainable yield; and the nutrient status, erosion, and compaction of soils. Tradeoff curves as estimated by the models will be tested with various scenarios originating from issues of changes identified by stakeholders. These include changes in dairy and potato production technologies, economic scenarios that change relative prices such as trade liberalization and taxes and subsidies on production inputs and outputs, policy interventions that induce land and water management changes such as subsidies for terraces, and climate change impacts. The indicators and scenarios were obtained through formal and informal elicitation processes with collaborators and other interested parties.

The project designed to integrate remote sensing, GIS, and dynamic models is being conducted at CONDESAN benchmark sites in the Altiplano of Bolivia and Peru. With an area greater than 600,000 km^2 and an average elevation of almost 4000 m, the Altiplano (southern Peru, western Bolivia, northern Chile, and northwestern Argentina) ranks second in size and elevation to only the Tibetan Plateau. As part of the central Andean mountain belt, the Altiplano of Bolivia and Peru is a region characterized by low average income levels, variability in agricultural prices, and high levels of uncertainty and risk for farm households. Weather-related events such as periodic droughts, frequent frosts, occasional floods, and seasonal wind erosion lead to most of the uncertainty and risk. In addition, crop yields in some areas may be reduced by soil salinity. Although some rural communities in the Altiplano have developed often complex social and economic mechanisms for managing risk in such a difficult environment, these systems and potentially new systems might be better understood through the use of methodologies and tools designed to capitalize on remote-sensed data, GIS, and process-based simulation models. Thus, the goal of this project is to develop and test methodologies for improving the accuracy in the simulation of agricultural production (pasture, crops, and livestock) in the Altiplano, by virtue of linking remote sensing, GIS, and dynamic models. The main output of the proposed research will be an "integrated assessment

system" – based on remote sensing, GIS, and process-based models – capable of estimating crop and animal production at different spatial aggregation scales (farm, landscape, region). Such a system will be useful for evaluating the current status of regional production, monitoring land-use changes, and conducting scenario analyses related to different policies and new technologies. Activities during 1997 included: (1) frost risk mapping – both temporal and spatial – of the Altiplano; (2) the use of NOAA-advanced very high resolution radiometer (AVHRR) data to assess biomass production; (3) mapping of primary production; (4) soil moisture and soil salinity using imagery from the European radar remote sensing satellite – synthetic aperture radar (ERS-SAR); (5) the validation of potato and pasture growth models; and (6) the training of collaborators in ground truthing, remote sensing, GIS, and crop growth models.

A common goal of both projects is to influence economic and environmental policy and direction of technological change at a variety of levels through the development of integrated assessment tools capable of performing scenario analyses. These tools, based on the integration of soil and crop simulation models, economic decision-making models, remote sensing data, and GIS, are to be packaged in user-friendly shells to support policy decision making by a variety of stakeholders such as politicians, agricultural and environmental research planners, and development specialists. Issues related to land use, production risks, soil management, nutrient management, and pesticide use are among the scenarios to be analyzed.


Workers monitor rice growth as part of the biological inhibitors trial in Vietnam.

Network-building activities important to the success of both projects were initiated during 1997 through workshops and training programs designed primarily to build regional capacity in the use of soil and crop simulation models. The IFDC scientist posted to CIP trained 86 scientists representing 30 regional institutions in the use of dynamic simulation models in 1-week training programs conducted in Bolivia, Colombia, Ecuador, and Peru. This cadre of regional scientists will be expected to furnish significant support for the continued development and testing of models and DSS for integrated assessments.

Philippines and Vietnam – Improving the Effectiveness of Biological Inhibitors – Rice is the staple food and the principal crop in Asia. It accounts for 30%-50% of agricultural incomes and provides 50%-80% of the calories consumed by the people. Rice production is most constrained by nitrogen availability to the crop. The common practice of urea application by broadcasting on the soil surface or into floodwater results in 50%-65% losses of applied nitrogen. The use of biological inhibitors to reduce gaseous nitrogen losses (not suitable for preventing runoff losses) and improve nitrogen use efficiency is a relatively simple operation when applied with urea. Urease inhibitors delay the conversion of urea to ammonium-nitrogen, thereby reducing the concentration of ammonium-nitrogen and its subsequent losses from the floodwater. Nitrification inhibitors likewise delay the conversion of ammonium-nitrogen to nitrate-nitrogen, which is prone to losses by denitrification and leaching. Improved use efficiency and yield gains of 10%-26% obtained with inhibitors were similar to those obtained with urea supergranules and polymer-coated fertilizers.

A Special Purpose Grant from ACIAR was used to determine the factors controlling the effectiveness of the most promising urease and nitrification inhibitors under variable field conditions. This work illustrates a number of ways for manipulating nitrogen transformation processes to conserve fertilizer nitrogen and increase grain yield. Field research was conducted in the

Philippines and Vietnam from 1995 to 1997 through the IFDC-International Rice Research Institute (IRRI) Program. During the dry season in the Philippines and during both the spring and summer seasons in Northern Vietnam, the urease inhibitors and a combination of urease and nitrification inhibitors resulted in significant yield increases and improved apparent fertilizer N recoveries. The significant yield gains and comparable performance of urea with urease and nitrification inhibitors versus deep point-placed USG or polymer-coated urea could make the urease inhibitor technology viable. This is particularly so in Vietnam and in those areas in Asia, e.g., Maligaya in the Philippines, where ammonia volatilization has been identified as the predominant loss process when urea fertilizer is broadcast into the floodwater. However, there is a place for the use of inhibitors in other rice-growing areas in Asia, United States, and Australia where fertilizer management and loss processes differ. For example, in New South Wales, even with the best urea management practices as outlined by *New South Wales Agriculture*, more than 60% of the applied nitrogen is lost from flooded rice. If nitrogen fertilizer is applied below the soil surface, ammonia loss is not an important loss process; denitrification becomes the predominant loss mechanism. The successful use of a nitrification inhibitor would reduce loss and lower the input of nitrogen fertilizer.

Information on the use of inhibitors for improving nitrogen fertilizer efficiency for rice has been transferred to other scientists through publications and presentations at international meetings. This information has also been synthesized and incorporated into the CERES-Rice Model. Transfer of these results to the agricultural industry now depends on the commercial production of urease inhibitors such as cyclohexyl phosphorictriamide (CHPT) and the commercial production of coated calcium carbide. The results provide a sound basis for further studies to increase yields, lower production costs in the rice industry, and reduce the contamination of the environment with lost fertilizer products. Future field research should include additional sites in other rice-growing areas of Asia, particularly during the wet season. More greenhouse research is needed to identify the effects of encapsulated calcium carbide (ECC) on floodwater chemistry, growth of rice, and pathogens. Ongoing efforts to validate the CERES-Rice Model with past inhibitor experiments will result in an improved systems tool, which then can be used to identify favorable areas for inhibitor applications.

Uruguay – Developing and Applying Information and Decision Support Systems in Latin America – During 1997 IFDC continued developing IDSSs in different countries. Such IDSSs include (1) large databases of information on prices, geographic information, soils, weather, farmer yields; (2) crop and pasture growth simulation models; (3) land use evaluation programs; and (4) a long-term soil organic matter simulation model. These components are linked with the GIS and, therefore, the results of the analyses are presented in the form of maps, which can be readily interpreted by stakeholders. Examples of the types of analyses that can be performed with these IDSSs include: national and regional crop yield forecasts, environmental and economical evaluation of agrotechnologies, assessments of the environmental impact of different production systems, and identification of optimal land use for different soil types.

In 1997 IFDC, in collaboration with the Instituto Agronomico de Parana (IAPAR), began the development of an IDSS for the state of Parana, Brazil, and continued expanding a previously developed IDSS for Uruguay. IFDC is incorporating into the new IDSSs satellite images for determining current land uses and for estimating dry-matter production. Information on climate anomalies and interannual/interseasonal climate variability (e.g., ENSO) is also being included in the IDSSs to improve the crop and pasture production forecasts. IFDC has encountered increasing interest in the establishment of IDSSs in the public and private sectors of different countries. In addition to capitalizing on the large volume of information generated in the past by the research institutes, the IDSSs are excellent tools for supporting the decision-making process in public institutions, private companies, and research centers.

Recommendations on fertilizer use and other crop management practices require information

on expected climate conditions for the crop-growing season. These expected weather conditions are typically inferred from long-term averages that in reality never exist, thus the recommendations are rendered inadequate. Recent scientific advances are allowing development of ENSO-based predictions that can now provide weather information at lead times of 3-6 months. These seasonal forecasts create the possibility of tailoring crop management recommendations to the expected weather conditions by taking advantage of favorable conditions and reducing the impacts of unfavorable conditions. In 1997 IFDC began a collaboration with the Climate Prediction Center (CPC) of NOAA and the International Research Institute for Climate Prediction (IRI) to apply seasonal weather forecasts in agriculture. These applications will also be included in the newest versions of IFDC's Information and Decision Support Systems.

Financial Highlights

The following is a summary of financial information for the year ended December 31, 1997. The full financial statements and the independent auditors' reports are available from IFDC upon request.

Balance Sheet

For the year ended December 31, 1997

	US $'000
Assets:	
Cash and cash equivalents	879
Short-term investments	189
Contributions receivable	922
Contracts receivable, net of allowance for doubtful accounts of $170,285	1,150
Other receivables	105
Supplies inventory	104
Prepaid expenses	28
Total current assets	3,377
Buildings and equipment, net	2,455
Contributions receivable, noncurrent	708
Total assets	6,540
Liabilities and Net Assets:	
Current portion of lease payable	17
Accounts payable	362
Accrued annual and sick leave	344
Deferred revenue	311
Total current liabilities	1,034
Lease payable, less current portion	59
Total liabilities	1,093
Unrestricted net assets	4,484
Temporarily restricted	963
Total liabilities and net assets	6,540

Statement of Revenue and Expenses

For the year ended December 31, 1997

	US $'000
Revenues and Support:	
Australian Center for International Agricultural Research	72
Bureau of Alcohol, Tobacco, and Firearms	802
Centro Internacional de Agricultura Tropical	154
The Citizens Network for Foreign Affairs	331
International Fertilizer Industry Association	77
International Fund for Agricultural Development	204
International Minerals Corporation	77
Netherlands Ministry for Development Cooperation (DGIS)	850
Ocean Farming Inc.	68
Petroquimica de Venezuela S.A.	540
Rockefeller Foundation	14
The Fertilizer Institute	119
The World Bank	162
U.S. Agency for International Development	6,018
Winrock International	187
Training Programs	306
Others	677
Total revenues and support	10,658
Expenses:	
Field programs	1,730
Research	1,723
Outreach	5,431
Supporting activities	1,942
Total expenses	10,826
Decrease in unrestricted net assets	**(168)**

FDC's Revenue Sources

Australian Center for International Agricultural Research (ACIAR)
Bariven, S.A.
Bureau of Alcohol, Tobacco, and Firearms (BATF)
Christmas Island Phosphates
Compagnie des Phosphates de GAFSA (CPG)
Der Bundesminister für Wirtschaftliche Zusammenarbeit of the Federal Republic of Germany (BMZ)
Entreprise Nationale de Fer et du Phosphate – Algeria (FERPHOS)
International Fertilizer Industry Association (IFA)
International Fund for Agricultural Development (IFAD)
International Minerals Corporation (IMC)
Jordan Phosphates Mines, Ltd.
Manah, S.A.
Netherlands Ministry for Development Cooperation (DGIS)
Norwegian Agency for Development (NORAD)
Ocean Farming, Inc.
Peace Corps (In Kind)
Pengedar Bahan Pertanian Sdn. Bhd. (PBP)
Petroquimica de Venezuela S.A. (PEQUIVEN)
Rockefeller Foundation
Swiss Agency for Development and Cooperation (SDC)
The Fertilizer Institute (TFI)
The World Bank
U.S. Agency for International Development (USAID)

IFDC's Staff (as of December 31, 1997)—

Office of the President

Amitava H. Roy, President and Chief Executive Officer
Alicia K. Hall, Senior Secretary
Debra E. Rutland, Executive Secretary
Marie K. Thompson, Senior Information Specialist
Daniel F. Waterman, Development Officer

Finance, Administration, and Support Services Unit

John H. Allgood, Director
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1. Left during 1997.
2. Extended leave.
3. Retired during 1997.
4. Deceased, 1997.
a. Seconded to IFDC by Directoraat Generaal Voor Internationale Samenwerking (Netherlands).

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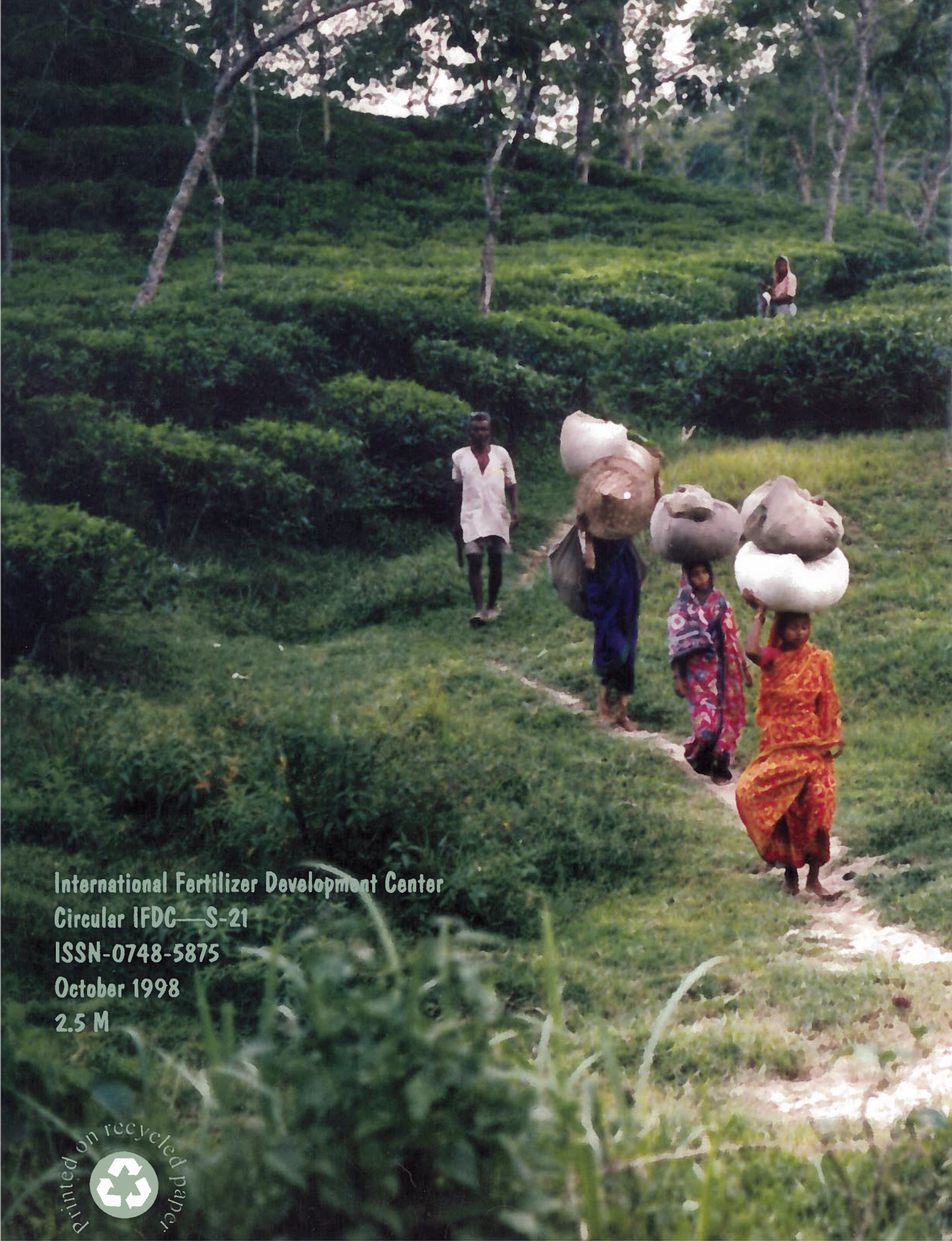

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