"Breaking the Cycle of Poverty and Hunger"

Annual Report 1999

International Fertilizer Development Center

IFDC Profile

IFDC is a public, nonprofit, international organization dedicated to conduct its work independently and on a scientifically sound basis. IFDC was founded in 1974 to help in the quest for global food security. The Center's goal is increasing agricultural productivity in a sustainable manner through the development and transfer of effective, environmentally sound plant nutrient technology and agricultural marketing expertise. The Center has conducted technology transfer activities in more than 120 countries. IFDC has contributed to the development of human resources and institutional capacity building in 150 countries through some 600 training programs. Its cadre of scientists and professionals provide a unique mix of applied research and technology transfer capabilities. The Center's facilities include libraries, laboratories, greenhouses, pilot plant, training facilities, and field stations in Africa.

Focus

IFDC's work focuses on:

- Policy analyses and reform and institutional capacity building to develop competitive markets for agricultural inputs and outputs;
- Provision of tools and information for more efficient and environmentally sound management of plant nutrients;
- Information and recommendations to improve and sustain soil fertility and land productivity;
- Provision of technical assistance and knowledge to enhance the efficiency and safety of plant nutrient production and supply;
- Training for human resource development in all areas of work.

Structure

IFDC's organizational structure is comprised of the following four operating divisions:

1. Research and Development; this division conducts strategic and applied research and training in nutrient management and soil fertility, crop modeling and fertilizer policy;
2. Outreach; this division concentrates on technical assistance and technology transfer and training to improve efficiency of the fertilizer and agriculture sectors;
3. IFDC-Africa, located at Lomé, Togo; this division addresses the constraints to improving soil fertility and agricultural productivity of countries in Africa, particularly those in the western region;
4. IFDC-Asia located in Dhaka, Bangladesh; this division concentrates on improving input and output marketing in the South and Southeast Asian countries.

In addition to these divisions, the Human Resources Development Unit coordinates global training programs and workshops. The Finance, Administration, and Support Services Unit coordinates the accounting, personnel, purchasing, word processing, graphics, library services, support services, and visitor relations for IFDC.

Locations and Funding

Besides its Headquarters in Muscle Shoals, AL (U.S.A.), IFDC has offices and staff stationed in Albania, Bangladesh, Ecuador, Kenya, Kosovo, Mozambique, Niger, Togo, Uruguay, and Washington, DC. The Center collaborates with the international agricultural research centers (IARCs), numerous national organizations, private-sector and nongovernmental organizations around the world. Partners and clients are diverse and include bilateral and multilateral development agencies, host-government institutions, and private enterprises. Much of the Center's revenue is generated from long-term, donor-funded, market development projects through which its staff members transfer policy and technology improvements in emerging economies.

Vision

The vision of IFDC focuses on contributing significantly to food security and economic progress by promoting sustainable agricultural development across the world through the efficient and environmentally sound management of plant nutrients in conjunction with other agricultural inputs and natural resources.

Mission Statement

To facilitate the sustainable improvement of agricultural productivity through the development and transfer of effective and environmentally sound plant-nutrient technology and agricultural marketing expertise.

IFDC Annual Report, 1999

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Acronyms

AAATA	Assistance to Albanian Agricultural Trade Associations
ACFD	African Centre for Fertilizer Development
AFADA	Albanian Fertilizer and Agribusiness Dealers Association
AIMSP	Agricultural Input Market Strengthening Project
ANMAT	Adapting Nutrient Management Technologies Project
ATDP	Agrobased Industries and Technology Development Project
BOYSCAST	Better Opportunity for Young Scientists in Chosen Areas of Science and Technology
CGIAR	Consultative Group on International Agricultural Research
CIAT	Centro Internacional de Agricultura Tropical
CIDA	Canadian International Development Agency
CIMMYT	Centro Internacional de Mejoramiento de Maiz y Trigo
CIP	Centro Internacional de la Papa
CNDC	Combating Nutrient Depletion Consortium
CNFA	The Citizens Network for Foreign Affairs
CORDAID	Catholic Organization for Relief and Development Aid
CPC	crop protection chemicals
DGIS	Netherlands Minister for Development Cooperation
DSS	Decision Support Systems
DSSAT	Decision Support Systems for Agro-Technology Transfer
EACP	East Africa Cereals Program
ECA	Economic Commission for Africa
ECAMAW	East and Central Africa Maize and Wheat
EMBRAPA	Empresa Brasileira de Pesquisa Agropecuaria
EPHTA	Ecoregional Program for the Humid and Subhumid Tropics of Sub-Saharan Africa
FAO	Food and Agriculture Organization of the United Nations
GDH	glutamate dehydrogenase
GDP	gross domestic product
GNP	gross national product
IAEA	International Atomic Energy Agency
IAR	Institute of Agricultural Research
IARCs	international agricultural research centers
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IDSS	Information and Decision Support System
IDST	Integrated Decision Support Toolbox
IFA	International Fertilizer Industry Association
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
IGAU	Indira Gandhi Agricultural University
IITA	International Institute for Tropical Agriculture
IMC	International Minerals and Chemical Corporation
INIA	National Agricultural Research Institute
INRAB	Institut National de Recherches Agricoles du Benin
IRRI	International Rice Research Institute
JIRCAS	Japan International Research Center for Agricultural Sciences
KODAA	Kosovo Dealers and Agri-Inputs Association
KR2	Second Kennedy Round
NARS	national agricultural research system
NGOs	nongovernmental organizations
NOAA	National Oceanic and Atmospheric Agency
NORAD	Norwegian Agency for Development
PMIL	Produce Mart International, Ltd.
RSMML	Rajasthan State Mining & Minerals Ltd.
SDC	Swiss Agency for Development and Cooperation
SRFSA	Sustaining the Restructured Fertilizer Subsector in Albania
SSA	sub-Saharan Africa
TFI	The Fertilizer Institute
TSBF	Tropical Soil Biology and Fertility Programme
TVA	Tennessee Valley Authority
UEMOA	West African Economic and Monetary Union
UNMIK	United Nations Mission in Kosovo
URA	Uruguay Round Agreement
USAID	U.S. Agency for International Development
USG	urea supergranule
VOCA	Volunteers in Overseas Cooperative Assistance

Letter From the Chairman of the Board

At the dawn of the 21st century, over 6 billion people inhabit the world. Approximately 3 billion of those people are earning less than 2 dollars per day, and nearly 800 million are suffering from hunger and malnutrition. While their counterparts in the developed countries are surfing in cyberspace, these people are tilling the soils and working hard to feed themselves—spending about 60% to 80% of their incomes on food. It is essential that additional food be produced at lower costs so that these people can feed themselves at satisfactory nutritional levels while spending less than one-half of their incomes.

The United Nations population projections indicate that world population will reach 8.9 billion in 2050. Not only must we produce enough food to eradicate hunger and malnutrition among adults and school-age children but also the world must be prepared to feed an additional 2 billion people—equal to the total population of India and China combined—in the first quarter of the 21st century.

The challenge of feeding over 8.9 billion people in 2050 must be confronted while protecting the environment. During the past 50 years, over 1 billion hectares of arable land has been degraded due to use of inappropriate agricultural practices. Soil degradation and deforestation resulting from inadequate replenishment of nutrients caused a large portion of this damage. Unless the removed nutrients are replenished adequately, soils cannot be sustained for posterity, and the removed nutrients cannot be adequately replenished unless mineral fertilizers are used. It is no exaggeration to say that there is no "sustainable food security" without mineral fertilizers.

Selling plantain (Aképé market)

"Status quo is disastrous for stagnant agriculture and low productivity. We must find a way to break out of this vicious cycle of hunger and poverty."

—Dr. Norman E. Borlaug (from the video, "Setting the Grassroots on Fire")

Efficient and environmentally sound fertilizer use depends on both appropriate technologies and policies. Supportive policies are indispensable for realizing the full potential of technologies. Policymakers and donors should work together to create a stable and favorable policy environment for fertilizer use and supply by providing price incentives, efficient organizations, adequate and affordable access to credit, to mention only a few components. IFDC is assisting countries like Albania, Bangladesh, Kosovo, and others, to create this kind of environment.

IFDC is recognized for the vital role that it is playing in the development of food security. In fact, during 1999, the Center was cited for its contributions in the Special Millennium Issue of *Farm Chemicals International.* IFDC and one of its Board members—Dr. Norman E. Borlaug—were selected as two of the top ten organizations and people that shaped the world during the past century. The late Mr. Travis P. Hignett of IFDC and Dr. Borlaug were listed among the top ten influencers that shaped 20th century agriculture. The special issue noted that IFDC has become "a global center of excellence, with expertise in fertilizers to service the needs of developing countries." In recognizing Mr. Hignett, the journal pointed out that "Key to fertilizer research in the 20th century have been the Tennessee Valley Authority (TVA) and IFDC, and Travis P. Hignett was the common thread to both. The 'Father of Fertilizer Technology' served for 35 years at TVA, was a special consultant at IFDC, and updated the *Fertilizer Manual*—a definitive work explaining major fertilizer-manufacturing processes." The journal named Dr. Borlaug "a key individual in the Green Revolution," who combined agricultural research and practical humanitarianism through plant breeding that boosted yields in some developing countries and won him the Nobel Peace Prize in 1970." During 1999 *Time* magazine recognized Dr. Borlaug as one of the greatest scientists and thinkers of the 20th century.

In this year's annual report, we are taking our theme of "Breaking the Cycle of Poverty and Hunger" from a video on Dr. Borlaug's life and work entitled "Setting the Grassroots on Fire." Quoting from the video, Dr. Borlaug says, "Status quo is disastrous for stagnant agriculture and low productivity. We must find a way to break out of that vicious cycle of hunger and poverty."

Throughout the pages of this annual report, the reader will find interesting, real-life accounts of individuals whose lives have been influenced by IFDC and its programs in Africa, Asia, Latin America, and Eastern Europe. IFDC looks forward to many more years of fruitful endeavors.

E. Travis York
Chairman of IFDC's Board of Directors

"One generation passeth away. . .
Another generation cometh. . .
But the earth abideth forever."

Ecclesiastes 1:4

Carta del Presidente de la Junta Directiva

Al comenzar el siglo 21, más de 6 mil millones de personas habitan la tierra. Aproximadamente 3 mil millones de estas personas devengan menos de 2 dólares al día, y casi 800 millones sufren de hambre y malnutrición. Mientras sus contrapartes en los países desarrollados traversan la Internet, éstas personas se encuentran arando el suelo o trabajando árduamente para alimentarse – gastando de 60% a 80% de sus entradas en alimentos. Es imprescindible que se logren producir alimentos adicionales a costos mas bajos para que esta mitad de la población pueda alimentarse a niveles nutricionales adecuados gastando menos de la mitad de sus ingresos.

Las proyecciones de población de las Naciones Unidas indican que la población mundial alcanzará 8.100 millones para el año 2025. Para esa época no sólo debemos producir suficientes alimentos para erradicar el hambre y la malnutrición entre adultos y niños en edad escolar, sino que debemos prepararnos para alimentar a los nuevos 2 mil millones de habitantes, igual que la población presente combinada de la India y la China.

El reto de alimentar a más de 8 mil millones de habitantes debe ser cumplido a la vez que se proteje al medio ambiente. Durante los últimos 50 años, más de mil millones de hectáreas de terrenos arables han sido degradados debido a prácticas agrícolas inapropiadas. Gran parte de este daño fue causado por degradación de suelos y la deforestación como resultado de la inadecuada reposición de nutrientes. Si no se reemplazan los nutrientes removidos por las cosechas, los suelos no pueden mantenerse adecuados para la posteridad, y los nutrientes no se pueden reemplazar a menos que se utilicen fertilizantes minerales. No es una exageración decir que no existe "seguridad alimenticia sustentable" sin el uso de fertilizantes minerales.

El uso eficiente y ambientalmente correcto de los fertilizantes depende tanto de las tecnologías como de políticas adecuadas. Para lograr el máximo potencial de las tecnologías es indispensable

que existan políticas que promuevan su uso y aplicación. Los forjadores de políticas y donantes, deben trabajar conjuntamente para crear un ambiente estable y favorable de políticas que promuevan el uso y suministro de fertilizantes mediante incentivos de precios, organizaciones eficientes, crédito adecuado y accesible, para mencionar solamente algunos de sus componentes. El IFDC está prestando asistencia a varios países tales como Albania, Bangladesh, Kosovo, y otros, a crear este tipo de ambiente.

Al IFDC se le reconoce por el importante papel que juega en el desarrollo de la seguridad alimenticia. De hecho, en 1999 la Edición Especial del Milenio de *Farm Chemicals International* citó al Centro por sus contribuciones. El IFDC y uno de sus miembros de la Junta Directiva – el Dr. Norman E. Borlaug – fueron seleccionados como dos de las diez organizaciones y personas que han tenido ingerencia en cambiar al mundo durante el siglo pasado. El finado Travis P. Hignett del IFDC y el Dr. Borlaug fueron ambos incluídos en la lista de las diez personas que han tenido más influencia en la agricultura del siglo XX. Esa edición especial anotó que el IFDC se ha convertido en un "centro global de excelencia, con experticia en fertilizantes, al servicio de las necesidades de los países en desarrollo." Hablando del Sr. Hignett, esta publicación indicó que "La Tennessee Valley Authority (TVA) y el IFDC han sido claves para la investigación en fertilizantes durante el siglo XX, y Travis P. Hignett fue la hebra común entre las dos organizaciones. El 'Padre de la Tecnología de Fertilizantes' trabajó 35 años en la TVA, fue un consultor especial en el IFDC y actualizó el *Manual de Fertilizantes* – obra singular que explica los principales procesos de producción de fertilizantes." La edición especial de *Farm Chemicals International* mencionó al Dr. Borlaug como "persona clave en la Revolución Verde," quien combinó la investigación agrícola con el humanitarianismo práctico a través del cultivo selectivo de plantas que incrementó los rendimientos de cosechas en algunos países en desarrollo y lo hizo merecedor del Premio Nobel de la Paz en 1970." Durante 1999 la revista Time reconoció al Dr. Borlaug como uno de los grandes científicos y pensadores del siglo XX.

En el informe anual de este año, estamos adoptando nuestro tema "Rompiendo el Ciclo del Hambre y la Pobreza," tomándolo de un video sobre la vida y el trabajo del Dr. Borlaug intitulado "Movilizando a la Gente de la Base (Setting the Grassroots on Fire)." En ese video el Dr. Borlaug dice, "El status quo es desastroso para el estancamiento de la agricultura y baja productividad. Debemos encontrar una manera en la cual se pueda romper el ciclo vicioso del hambre y pobreza."

A través de las páginas de este informe annual, el lector encontrará recuentos interesantes y reales de indivíduos cuyas vidas han sido influenciadas por el IFDC y sus programas en Africa, Asia, América Latina, y Europa Oriental. El IFDC anticipa logros fructíferos a través de muchos años de trabajo.

E. Travis York
Presidente de la Junta
Directiva del IFDC

"Una generación pasa...
Otra generación llega...
Pero la tierra permanece siempre."

Eclesiastés 1:4

Lettre du Président du Conseil d'Administration

A l'aube du 21ème siècle, plus de 6 milliards d'habitants peuplent la planète. Autour 3 milliards d'entre eux gagnent moins de 2 dollars par jour, et près de 800 millions souffrent de famine et de malnutrition. Pendant que leurs pairs des pays développés naviguent dans l'espace cybermetrique, ces populations labourent la terre et travaillent dur pour se nourrir— dépensant environ 60% à 80% de leurs revenus sur l'alimentation. Un accroissement de la production agricole à un coût bas est donc nécessaire pour permettre à ces populations de pouvoir se nourrir d'elles-mêmes de manière satisfaisante avec moins de la moitié de leurs revenus.

Les projections des Nations Unies indiquent que la population mondiale atteindra 8,9 milliards d'habitants en l'an 2050. Non seulement devons-nous produire suffisamment de nourriture pour éradiquer la famine et la malnutrition parmi les adultes et les enfants en age de scolarisation, mais aussi devons-nous nous apprêter à nourrir 2 milliards d'habitants supplémentaires— équivalent à la population totale de l'Inde et la Chine pris ensemble— pendant le premier quart du 21ème siècle.

Le défi de nourrir plus de 8,9 milliards d'habitants en l'an 2050 doit être relevé tout en protégeant l'environnement. Durant ces 50 dernières années, plus d'un milliard d'hectares de terres arables ont été dégradées par l'utilisation de techniques agricoles non appropriées. La dégradation des sols et la déforestation résultant d'une restitution non adéquate des éléments nutritifs extraits du sol en sont en grande partie responsables. A défaut d'une restitution adéquate de ces éléments nutritifs, ces sols ne pourront pas être utilisés de manière durable. Par ailleurs, les éléments nutritifs extraits des sols ne peuvent pas leur être restitués de manière adéquate sans l'utilisation d'engrais minéraux. Il n'est donc pas exagéré de dire qu'il n'y a pas de "sécurité alimentaire durable" sans engrais minéraux.

L'utilisation efficiente des engrais soucieuse de la protection de l'environnement dépend à la fois des technologies et politiques appropriées. Des politiques favorables sont nécessaires pour l'exploitation du potentiel des technologies. Les décideurs politiques et bailleurs de fonds devraient travailler ensemble pour créer un environnement stable et favorable à l'approvisionnement et l'utilisation des engrais. Les éléments constitutifs de cet environnement favorable incluent entre autres des incitations de prix, des organisations efficientes, et un accès adéquat au crédit à un coût abordable. L'IFDC assiste des pays comme l'Albanie, Bangladesh, Kosovo, et autres dans la création d'un tel environnement.

L'IFDC est reconnu pour le rôle vital qu'il joue pour le développement de la sécurité alimentaire. En effet, en 1999, l'IFDC avait été reconnu pour ses diverses contributions dans le Numéro Spécial du Millenium de la revue *Farm Chemicals International* . Par ailleurs, l'IFDC et l'un des membres de son Conseil d'Administration — Dr. Norman E. Borlaug— avaient été sélectionnés parmi les 10 premières institutions et personnalités ayant le plus influencées le monde au 20ème siècle. Le feu Mr. Travis P. Hignett de l'IFDC et Dr. Norman E. Borlaug avaient été cités parmi les 10 premières personnalités ayant le plus influencées l'agriculture mondiale au 20ème siècle. Ce numéro spécial de cette revue avait indiqué que l'IFDC était devenu "un centre mondial d'excellence d'expertise en matière d'engrais au service des pays en voie de développement". En reconnaissant la contribution de Mr. Hignett, cette revue avait mentionné que "le Tennessee Valley Authority (TVA) et l'IFDC étaient devenus la plaque tournante de la recherche sur les engrais au 20ème siècle, et Travis P. Hignett le lien entre les deux organisations. "Père de la technologie des engrais", Mr. Hignett avait travaillé pendant 35 ans au TVA, avait été consultant spécial de l'IFDC, et avait actualisé le manuel *Fertilizer Manual*— oeuvre définitive expliquant les principaux processus de production des engrais." La revue avait reconnu le Dr. Borlaug comme étant "un homme clé de la Révolution Verte" qui a su combiner la recherche agricole et les oeuvres humanitaires à travers une amélioration génétique des plantes qui a accru les rendements de manière significative dans plusieurs pays en voie de développent et lui a valu le Prix Nobel de la Paix en 1970."

Dans ce rapport annuel, nous empruntons notre thème "Briser le Cercle de la Pauvreté et la Famine" de la cassette vidéo portant sur la vie et l'oeuvre du Dr. Borlaug intitulée "Setting the Grassroots on Fire". Dans cette vidéo, le Dr. Borlaug mentionne que "le statu quo est désastreux pour une agriculture stagnante et à faible productivité. Nous devons trouver un moyen pour sortir de ce cercle vicieux de la famine et la pauvreté."

A travers les pages de ce rapport, le lecteur trouvera d'intéressants récits des individus dont les vies ont été influencées par l'IFDC et ses programmes en Afrique, en Asie, en Amérique Latine, et en Europe de l'Est. L'IFDC envisage un avenir fait de plusieurs autres années de fructueux efforts.

"Une génération s'est écoulée...
Une autre génération commence...
Mais la terre supporte à jamais."

Ecclesiastes 1:4

E.T. Travis York
Président du Conseil
d'Administration de l'IFDC

IFDC's First 25 Years

Message From IFDC's President and Chief Executive Officer

The year 1999 marked a milestone in the history of IFDC. On November 1, 1999, we celebrated IFDC's 25th Anniversary. Twenty-five years ago, at the urging of the international community led by the United States at the U.N. General Assembly, IFDC was established to address the issues of food production in developing countries of the tropics and subtropics. The primary focus was to improve fertilizer efficiency and transfer fertilizer know-how to the developing countries.

Over the years IFDC has realized many accomplishments that have been very aptly articulated in a letter to me by Dr. Nyle Brady, Emeritus Professor, Cornell University, also former Director General of the International Rice Research Institute (IRRI) in the Philippines, and former official of the U.S. Agency for International Development (USAID).

Quoting Dr. Brady, "It has been my privilege to observe the emerging contributions of IFDC as it has helped farmers and their national and international compatriots gain a better understanding of the critical role of plant nutrients in helping the world feed itself. . . . the international accomplishments of this Center have clearly shown that this is an institution with a global mandate and with a truly global impact. One of the strengths of IFDC's programs is the extent to which they have focused on low-income farmers in low-income countries. In collaboration with scientists and educators in developing countries, IFDC has helped assess the supply and availability of plant nutrients from both organic and inorganic forms. IFDC has helped discover or develop appropriate systems to effectively utilize and recycle these nutrients, and has created models that helped its cooperators extrapolate their findings from one ecoregion to another. IFDC must be congratulated for having helped them blend the best of science with the down-to-earth management abilities of small farmers."

The accomplishments of which Dr. Brady wrote would not have been possible without the vision and efforts of my predecessors—Dr. Donald L.

McCune, IFDC's first Managing Director; the late Dr. David B. Parbery; and Dr. Paul J. Stangel. I recognize their contributions in paving the way for the role that IFDC plays in the international arena today. Giants in the field of international agricultural development—the late Sir John Crawford of Australia and the late Dr. John Hannah, IFDC's first Chairman of the Board—were also instrumental in setting the stage for the future role that IFDC would play in improving the lives of poor people of many developing countries. Equally important have been the contributions of IFDC's dedicated staff who have spent countless hours away from home in order to make a difference in the lives of many people of the developing countries.

Since it was established in 1974 IFDC has conducted technology transfer activities in more than 120 countries and now has offices in nine countries in Africa, Asia, Latin America, and Europe. IFDC has contributed to the development of human resources and institutional capacity building through some 600 training programs, conducted in Muscle Shoals and other locations, for more than 7,500 participants from some 150 countries. Dr. Brady has called IFDC's training activities—"consistently effective human resource and institution development programs that have been especially beneficial to public and private sector institutions as well as small farmers."

Without the support of our donors and the partnerships that IFDC has formed with national and international agricultural research centers, nongovernmental organizations, private companies, scientists, and farmers around the world, IFDC could not have reached the milestones in agricultural development that it has attained.

The founders of IFDC created this unique institution because they were committed to fighting hunger, combating its cause—poverty—and inhibiting the wider consequences of both. We have deepened our understanding of these issues over time. Today we must harness that understanding into a new vision as we confront the challenges of a new millennium. Even though the marvels of science are paving the way for us to reach new heights, there are still millions of malnourished children in the world today. More than 1.3 billion people live with less than US $1 per day income and more than 2 billion people are only slightly better off. IFDC recognizes that over the next quarter century it has to redouble its efforts as part of the international development community to promote sustainable development and end human misery. Human existence depends on land, which is the first link in the food production chain. IFDC research and development directly affects the soil health and, subsequently, food production.

During 1999 IFDC realized yet additional milestones as it advanced its programs in research, agribusiness, technology transfer, and human resource development. The highlights section of this report outlines some of these achievements. Feature articles spotlight some of the more notable accomplishments in research, agribusiness, and technology transfer.

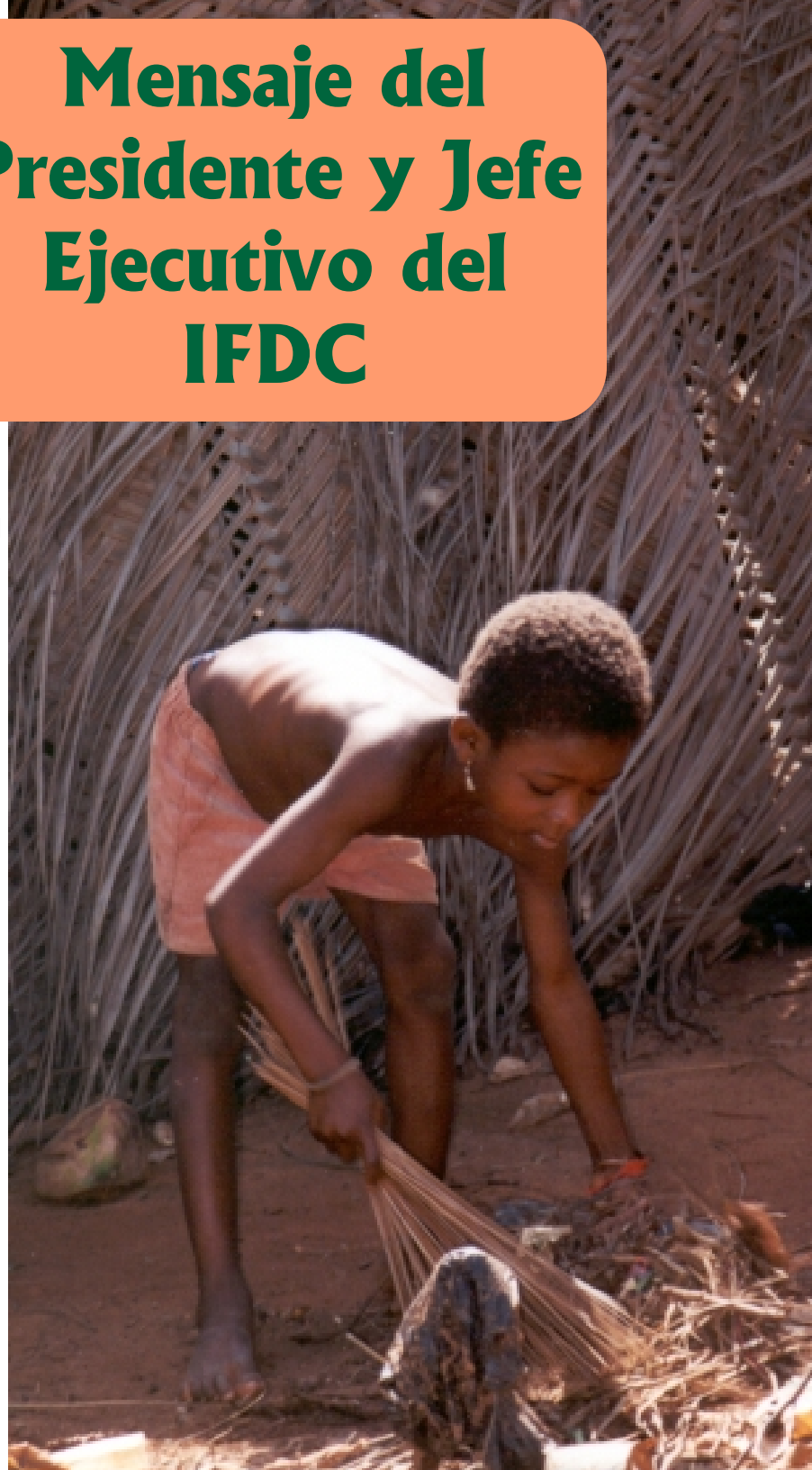
With the continued support of its donors and through collaborative relationships with other organizations, IFDC looks toward the realization of more successes in the future.

"Upon this handful of soil our survival depends. Husband it, and it will grow our food, our fuel, and our shelter, and surround us with beauty. Abuse it and the soil will collapse and die, taking man with it."

—Sanskrit proverb, 1500 BC

Amit H. Roy
IFDC President and
Chief Executive Officer

Mensaje del Presidente y Jefe Ejecutivo del IFDC



El Año 1999 ha marcado un hito en la historia del IFDC. El 1º de noviembre celebramos el Vigésimo Quinto Aniversario del IFDC. Hace 25 años, a instancias de la comunidad internacional en la Asamblea General de O.N.U. impulsada por los Estados Unidos, se estableció el IFDC para atender a los problemas de producción alimenticia en los países en desarrollo de los trópicos y subtrópicos. El enfoque principal del IFDC fue mejorar la eficiencia de los fertilizantes y transferir los conocimientos sobre éstos a los países en desarrollo.

A través de los años, el IFDC ha alcanzado numerosos logros los cuales han sido muy aptamente articulados en una carta recientemente dirigida a mí por el Dr. Nyle Brady, Profesor Emérito de la Universidad de Cornell, anterior Director General del Instituto Internacional para la Investigación de Arroz (IRRI) en las Filipinas, y antiguo oficial de la Agencia Estadounidense para el Desarrollo Internacional (USAID).

Según dice el Dr. Brady, "Ha sido mi privilegio observar las crecientes contribuciones hechas por el IFDC a medida que ha ayudado a los agricultores y a sus compatriotas nacionales e internacionales a adquirir un mejor entendimiento del papel crítico que juegan los nutrientes de plantas en ayudar al mundo a alimentarse....los alcances internacionales de este Centro han demostrado claramente que ésta es una institución con un mandato global y con un impacto verdaderamente global. Una de las fuerzas de los programas del IFDC es el grado en el cual se le ha hecho enfoque al agricultor de bajos recursos en países de bajos recursos. En colaboración con varios científicos y educadores en países en desarrollo, el IFDC ha ayudado a evaluar el suministro y la disponibilidad de nutrientes de plantas tanto orgánicos como inorgánicos. El IFDC ha ayudado a descubrir o desarrollar sistemas apropiados que utilizan y reciclan efectivamente estos nutrientes, y ha creado modelos que ayudan a sus colaboradores a extrapolar sus resultados de una ecoregión a otra. El IFDC debe ser felicitado por haberlos ayudado a combinar la mejor ciencia con las capacidades sencillas de manejo de los pequeños agricultores."

Los logros a los cuales se refiere el Dr. Brady no habrían sido posibles sin la visión y los esfuerzos de mis predecesores – el Dr. Donald L. McCune, primer Director Gerente del IFDC; el Dr. David B. Parbery, fallecido; y el Dr. Paul J.

Stangel. Reconozco sus contribuciones en abrir el camino al papel que juega el IFDC en el mundo internacional hoy en día. Los gigantes en el campo internacional de desarrollo agrícola como Sir John Crawford, fallecido, de Australia y el Dr. John Hannah, fallecido, primer Presidente de la Junta de Directores del IFDC, también fueron personas claves en sentar las bases para desarrollar el papel que el IFDC iba a tener en el mejoramiento de las vidas de la gente pobre en muchos países en desarrollo. De igual importancia han sido las contribuciones del personal del IFDC, quienes en forma dedicada han pasado incontables horas lejos de sus hogares para poder ayudar en forma significativa a mejorar la vida de mucha gente en países en desarrollo.

Desde su establecimiento en 1974, el IFDC ha llevado a cabo actividades de transferencia de tecnología a más de 120 países y ahora tiene oficinas en nueve países en Africa, Asia, Latinoamérica, y Europa. El IFDC ha contribuído al desarrollo de los recursos humanos y al aumento de la capacitación institucional a través de unos 600 programas de entrenamiento llevados a cabo en Muscle Shoals y otros lugares que han favorecido a más de 7.500 participantes de unos 150 países. El Dr. Brady ha declarado que las actividades de entrenamiento del IFDC – "son programas de desarrollo de recursos humanos e instituciones, consistentemente efectivos, que han sido especialmente benéficos a las instituciones del sector público y privado como también a los pequeños agricultores."

Sin el apoyo de nuestros donantes y los lazos de colaboración que el IFDC ha formado con centros nacionales e internacionales de investigación agrícola, organizaciones no gubernamentales, empresas privadas, científicos y agricultores alrededor del mundo, el IFDC no hubiera podido lograr los hitos en el desarrollo agrícola que ha alcanzado.

Los fundadores del IFDC crearon esta institución sin igual porque estaban dedicados a luchar contra el hambre, combatiendo su causa – la pobreza – e inhibiendo las amplias consecuencias de ambos. Hemos profundizado nuestro entendimiento sobre estos temas a través del tiempo. Hoy debemos forjar estos entendimientos y transformarlos a una nueva visión a medida que afrontamos los retos de un nuevo milenio. A pesar de que las maravillas de la ciencia nos están abriendo caminos para escalar nuevas metas, existen todavía millones de niños malnutridos en el mundo de hoy en día. Más de 1,3 mil millones de personas viven con menos de US $1 de ingresos por día y más de 2 mil millones están apenas un poco mejor. El IFDC reconoce que en el próximo cuarto de siglo necesita redoblar sus esfuerzos como parte de la comunidad internacional para el desarrollo con el fin de promover el desarrollo sostenible y darle fín a la miseria humana. La existencia humana depende de la tierra, que es el primer eslabón en la cadena de producción alimenticia. Las investigaciones y los desarrollos del IFDC directamente afectan la salud del suelo y por consiguiente la producción de alimentos.

Durante 1999, el IFDC obtuvo nuevos logros impulsando sus programas de investigación, agronegocios, transferencia de tecnología, y desarrollo de recursos humanos. La sección de este informe que resalta las actividades del Centro hace un esbozo de varios de estos logros. Los artículos de fondo describen algunas de las realizaciones que son más notables en investigación, agronegocios, y transferencia de tecnología.

Con el contínuo patrocinio de sus donantes y a través de relaciones colaborativas con otras organizaciones, el IFDC anticipa la realización de mayores logros en el futuro.

"Nuestra supervivencia depende de este manejo de suelo. Protégelo, y él te dará nuestra comida, nuestro combustible y nuestro resguardo, y nos rodeará con belleza. Abúsalo y el suelo se derrumbará y morirá y se llevará al hombre consigo."
—Proverbio Sánscrito, 1500 AC

Amit H. Roy
Presidente y Jefe
Ejecutivo del IFDC

Message du Président-Directeur Général de l'IFDC

L'année 1999 marque un important jalon dans l'histoire de l'IFDC. Le 1 novembre 1999, nous avons célébré le 25ème anniversaire de l'IFDC. Il y a 25 ans en effet, sur la demande pressante de la communauté internationale menée par les Etats Unis d'Amérique à l'Assemblé Générale des Nations Unies, l'IFDC avait été créé pour s'attaquer aux problèmes qui sont à la base de la faiblesse de la production agricole dans les pays tropicaux et subtropicaux en voie de développement. L'objectif principal était d'améliorer l'efficacité des engrais et le transfert du savoir-faire technologique en matière d'engrais aux pays en voie de développement.

Au cours des années, l'IFDC a réalisé plusieurs accomplissements qui ont été éloquemment articulés dans une lettre qui m'a été adressée par le Dr. Nyle Brady, Professeur Emérite de l'Université de Cornell— par ailleurs ancien Directeur Général de l'Institut International de Recherche sur le Riz (IRRI), et ancien fonctionnaire de l'Agence Américain pour le Développement International (USAID).

Pour citer le Dr. Brady, "Ça été un privilège pour moi d'observer les contributions émergentes de l'IFDC à travers son assistance aux paysans et leurs compatriotes nationaux et internationaux à mieux comprendre le rôle critique des éléments nutritifs des plantes dans la satisfaction des besoins alimentaires dans le monde.... les réalisations internationales de ce Centre ont clairement monté que c'est une institution ayant un mandat d'envergure mondial et dont l'impact est véritablement global. L'une des forces des programmes de l'IFDC est l'envergure de sa concentration sur les paysans les moins nantis dans les pays à revenus faibles. En collaboration avec les hommes de science et éducateurs dans les pays en voie de développent, l'IFDC a contribué de manière significative à l'évaluation de l'apport et la disponibilité des éléments nutritifs des plantes sous formes organique et inorganique. L'IFDC a contribué à la découverte et au développement de systèmes appropriés pour l'utilisation effective et le recyclage de ces éléments nutritifs, et a mis au point des modèles ayant permis à ses différents collaborateurs d'extrapoler les résultats obtenus dans une région écologique à une autre. L'IFDC est à féliciter pour son assistance à ses partenaires à mieux associer la quintessence scientifique et les capacités de gestion des petits paysans."

Les réalisations auxquelles le Dr. Brady fait allusion n'auraient pas été possibles sans la vision et les efforts de mes prédécesseurs— Dr. Donald L. McCune, premier Directeur Général de l'IFDC; feu Dr. David B. Parbery; et Dr. Paul J.

Stangel. Je reconnais ici que leurs contributions ont posé les bases qui ont permis à l'IFDC de jouer son rôle actuel sur la scène internationale. Géants de la scène internationale du développement agricole, feu Sir John Crawford de l'Australie et feu Dr. John Hannah—premier Président du Conseil d'Administration de l'IFDC— ont aussi été d'un apport décisif dans la mise à voie du rôle que joue aujourd'hui l'IFDC dans l'amélioration des vies des populations pauvres dans plusieurs pays en voie de développement. Toutes aussi importantes ont été les contributions du très dévoué personnel de l'IFDC qui a passé d'incalculables heures loin de leurs familles pour contribuer à l'amélioration des vies de nombreux habitants dans plusieurs pays en voie de développement.

Depuis sa création en 1974 l'IFDC a mené des activités de transfert de technologies dans plus de 120 pays, et a présentement des bureaux dans neuf pays en Afrique, en Asie, en Amérique Latine, et en Europe. L'IFDC a contribué au développement des ressources humaines et capacités institutionnelles à travers environ 600 programmes de formation organisés à Muscle Shoals et dans plusieurs autres localités. Ces programmes de formation ont été suivis par plus de 7.500 participants venus d'environ 150 pays. Dr. Brady a qualifié les programmes de formation de l'IFDC de "programmes effectifs de développement des ressources humaines et capacités institutionnelles qui ont particulièrement été bénéfiques aux institutions publiques et privées, ainsi qu'aux petits paysans."

L'IFDC n'aurait pas pu franchir ces différents jalons dans le développement agricole sans le soutien de ses bailleurs de fonds et les partenariats qu'il a formé avec de nombreux centres de recherche agricole nationaux et internationaux, des organisations non gouvernementales, des entreprises privées, des hommes de science, et plusieurs paysans à travers le monde.

Les fondateurs de l'IFDC ont créé cette unique institution en raison de leur dévouement à combattre la famine, à mener la guerre contre sa cause–la pauvreté—, et à atténuer les conséquences profondes de ces deux phénomènes. Avec le temps, nous avons approfondi notre compréhension de ces phénomènes. Nous devons maintenant exploiter cette compréhension à travers une nouvelle vision, confrontés que nous sommes aux défis du nouveau millénium que nous avons l'obligation de relever. Bien que les merveilles scientifiques nous ouvrent de nouveaux horizons, il existe encore dans notre monde d'aujourd'hui des millions d'enfants mal nourris. Plus de 1,3 milliards d'habitants du globe vivent d'un revenu de moins US $1 par jour, et plus de 2 milliards vivent légèrement mieux qu'avant. L'IFDC reconnaît qu'au cours du prochain quart de siècle il doit redoubler ses efforts en tant que membre de la communauté internationale pour la promotion d'un développement durable et la fin de la misère humaine. L'existence de la race humaine dépend de la terre, premier maillon de la chaîne alimentaire. La recherche et développement au sein de l'IFDC influencent directement l'état du sol et, par conséquent, la production agricole.

En 1999 l'IFDC a franchi d'autres nouveaux jalons en promouvant ses programmes de recherche, d'agribussiness, de transfert de technologies, et de développement des ressources humaines. La section *Highlights* de ce rapport souligne certains de ces jalons. La section *Feature Articles* identifie certaines des contributions les plus remarquables.

Avec le soutien continu des bailleurs de fonds et à travers des relations de collaborations avec d'autres organisations, l'IFDC envisage l'avenir avec le souci de réaliser de nouveaux succès.

"De cette poignée de terre dépend notre survie. Ménageons-là, et elle produira notre nourriture, notre énergie, et notre abri, et nous entourera de merveilles. Abusons d'elle et elle s'effondrera et périra, entraînant l'homme avec elle."

—proverbe Sanskrit, 1500 avant JC

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

Guest Essay by Dr. Vaclav Smil

Excerpt from *Long-Range Perspectives on Inorganic Fertilizers in Global Agriculture*

The World's Dependence on Inorganic Fertilizers

The agronomic means of producing the requisite amount of food and feed are well known under a misleading term of the Green Revolution. Like so many other grand transformations in human history, this revolution has been gradual; it has progressed unevenly in different parts of the world; and it has not been without unintended, unforeseen and undesirable consequences. However, there can be no doubt about its overall positive effect (Figure 1), and the role of inorganic fertilizers in its success has been essential. I can do no better than to quote Norman Borlaug, one of the leaders in developing and diffusing new high-yielding cultivars, who summed up the importance of fertilizer nitrogen in his speech accepting the Nobel Prize for Peace in 1970 by using a memorable kinetic analogy:[1]

> If the high-yielding dwarf wheat and rice varieties are the catalysts that have ignited The Green Revolution, then chemical fertilizer is the fuel that has powered its forward thrust…

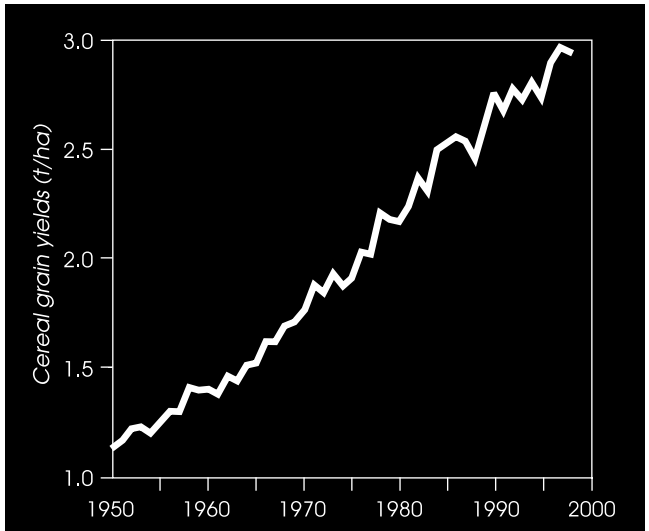


Figure 1. Average Global Yields of Cereal Grains, 1950-98; Plotted From the FAOSTAT Data (FAO, 1999).

Compared to 1950 the recent global use of fertilizers is about 23 times higher in the case of nitrogen, almost eight times higher for phosphorus, and more than four times higher for potassium (Figure 2). Of course, these global means hide enormous inter- and intranational differences, and there are also great disparities in fertilizer applications to primary crops.[2] Consequently, a more meaningful approach is to use the world's major crops or the most intensively cultivated regions for longitudinal comparisons.

As part of IFDC's Celebration of its 25th Anniversary during 1999, the Center welcomed Dr. Vaclav Smil, a Distinguished Professor at the University of Manitoba, Canada, to present the Second Travis P. Hignett Memorial Lecture. Smil's lecture illustrated the importance of fertilizer to the world. An excerpt from his lecture, entitled *Long-Range Perspectives on Inorganic Fertilizers in Global Agriculture*, is presented here.

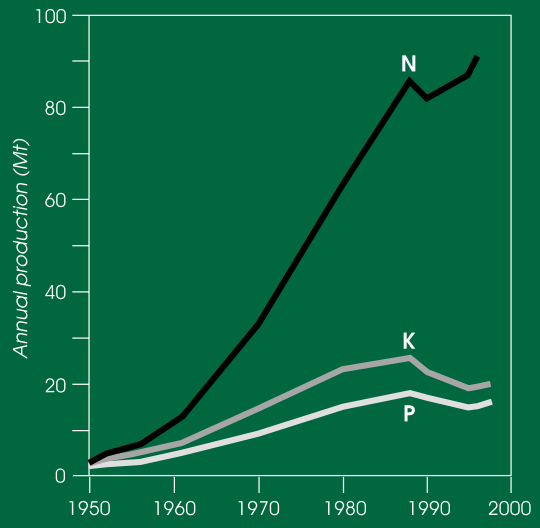


Figure 2. Global Production of Inorganic Fertilizers, 1950-2000.

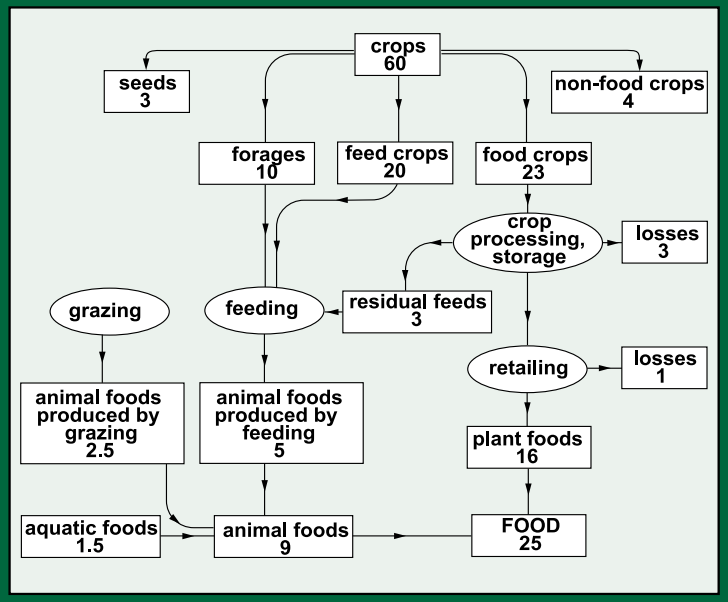


Figure 3. Nitrogen in the Global Food and Feed Harvest of the Mid-1990s (All Values Are in Mt N/Year).

Using a prime North American example, in 1950 the U.S. corn, not all of it seeded with hybrid varieties, received less than 8 kg N, 5 kg P, and about 6 kg K per planted hectare, and it yielded less than 2.5 t/ha. Today the all-hybrid and partially transgenically modified crop averages 8 t/ha, and it receives, respectively, 140, 60 and 70 kg N, P and K.[3] China's most productive double-cropped paddies in Hunan or Jiangsu, which received no inorganic fertilizer in 1950 and yielded less than 2.5 t/ha, now receive more than 400 kg N/ha, and a single crop produces over 6 t/ha.[4]

I have prepared a detailed account of nitrogen flows in global agriculture, which shows that during the mid-1990s about 85% of all nitrogen in food proteins available for human consumption (21 out of 24.5 Mt N) came directly in plant foods or indirectly via animal products from the world's cropland; the rest comes from pastures and from aquatic foods (Figure 3).[5] Because synthetic nitrogen fertilizers provided about half of the nutrient in harvested crops (the most likely range of my calculations is 44%-51%), roughly 40% (37%-43%) of the world's dietary protein supply in the mid-1990s originated in the Haber-Bosch synthesis of ammonia. This global mean both overestimates and underestimates the degree of our dependence on the Haber-Bosch process because the applications of nitrogen in affluent nations have a very different role from the nutrient's use in low-income countries.

Current global per capita mean of the dietary protein supply—about 73 g/day—is composed of two disparate parts: (1) a huge excess in the rich world (per capita mean of almost 100 g/day, including about 55 g from animal foods) and (2) a much less comfortable rate in the low-income countries of Asia, Africa and Latin America, where the 1996 per capita mean was about 66 g/day, with only about 18 g coming from animal foods.[6]

Clearly, protein supply has not been a concern in affluent nations where higher use of fertilizers during the latter half of the 20th century has merely added more meat and dairy products to diets that were already sufficient in animal protein. However, protein supply is still a challenge in most of the low-income countries (Figure 4).[7] Estimating the share of dietary protein derived from nitrogen fertilizers that are applied in low-income countries provides a good idea of the extent of a truly existential dependence on the Haber-Bosch synthesis.

Low-income countries now consume about two-thirds of the world's nitrogen fertilizers, which provided about 55% of the total nutrient supply reaching their fields.[8] Because no less than 92% of their food proteins were derived from crops, inorganic fertilizers supplied at least half of all nitrogen in their diets. This would be an equivalent of feeding no less than 2.2 billion people or roughly 40% of the world's 1996 total population: these people now depend on the Haber-Bosch synthesis for what is, on the average, a barely sufficient supply of their basic food needs, that is, for their very survival.

Another estimate of our dependence on ammonia synthesis can be obtained by an entirely different approach—by calculating the population totals supportable by specified diets. In 1900 the virtually fertilizer-free agriculture was able to sustain 1.625 billion people by a combination of extensive cultivation and organic farming on the total of about 850 Mha. The same combination of agronomic practices extended to today's 1.5 billion ha of cropland would feed about 2.9 billion people or about 3.2 billion when adding the food derived from grazing and fisheries. This means that without nitrogen fertilizers no more than 53% of today's population could be fed at a generally inadequate per capita level of 1900 diets. If we were to provide today's average per capita food supply with the 1900 level of agricultural productivity, we could feed only about 2.4 billion people or just 40% of today's total.

The range of our dependence on the Haber-Bosch synthesis of ammonia is thus as follows: for about 40% of humanity it now provides the very means of survival; only half as many people as are alive today could be supplied by pre-fertilizer agriculture with very basic, overwhelmingly vegetarian, diets; and pre-fertilizer farming could provide today's average diets to only about 40% of the existing population.

The only way this global dependence on nitrogen fertilizer could be lowered would be to adopt an unprecedented degree of sharing and restraint. Because the world's mean daily protein supply of nearly 75 g/capita is well above the needed minimum, equitable distribution of available food among the planet's 6 billion people who are content to subsist on frugal, but adequate, diets would provide enough protein even if the global food harvests were to be some 10% lower than they are today.

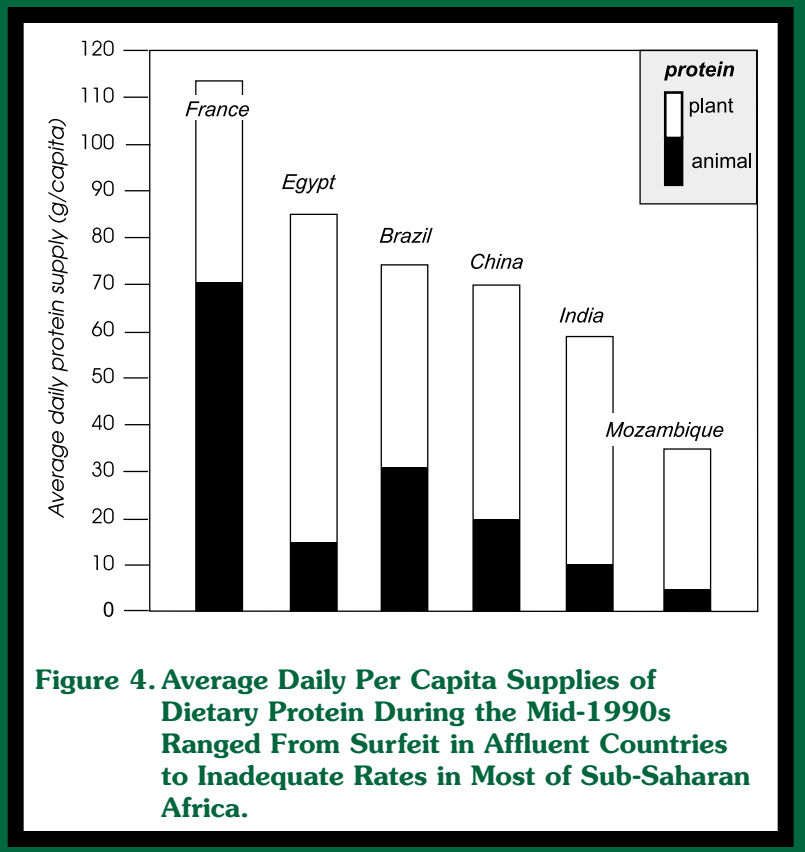


Figure 4. Average Daily Per Capita Supplies of Dietary Protein During the Mid-1990s Ranged From Surfeit in Affluent Countries to Inadequate Rates in Most of Sub-Saharan Africa.

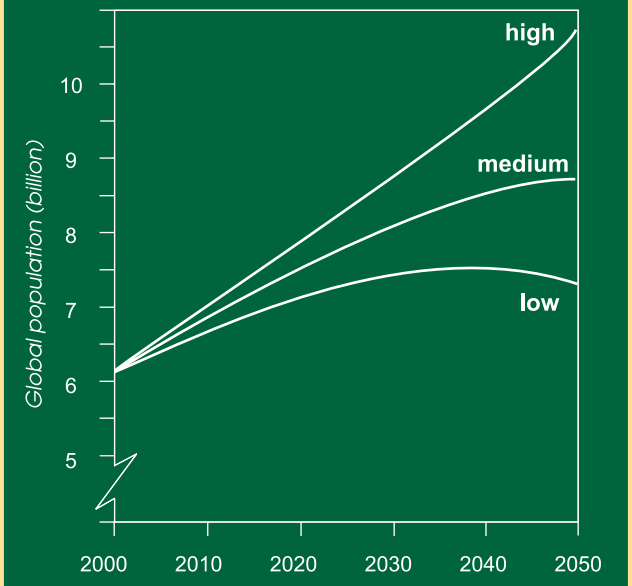


Figure 5. Possible Growth Curves of Global Population, 2000-2050.

In such a world the populations of affluent countries would have to reduce their meat consumption since hundreds of millions of people would have to revert to simpler diets containing more cereals and legumes. Realistic chances of this dietary transformation, running directly against the long-term trend of global nutritional transitions, are extremely slim, but even in such an altruistic and frugal world, ammonia synthesis would still have to supply at least one-third of all nitrogen assimilated by the global food harvest! However, in the absence of any altruistic sharing, the only way to eliminate the existing stunting and malnutrition caused by protein shortages among hundreds of millions of disadvantaged peasants and the poorest urban dwellers in low-income countries is to intensify global food production and, hence, to increase the world's dependence on fertilizers.

Growing Dependence During the 21st Century

High absolute rates of global population growth will remain by far the most important reason for the increased used of inorganic fertilizers. There can be no doubt that the transition to low fertility—a shift completely accomplished in all affluent countries and well advanced in much of Asia and Latin America—is now under way even in sub-Saharan Africa, the largest remaining region of very high birth rates. As a result, the world's population growth has recently begun declining even in absolute terms. Depending on the more distant, and as yet uncertain, course of the fertility decline, global population may be between 7.3 and 10.7 billion people by the year 2050. The United Nations' latest medium forecast is about 8.9 billion, and this total may not increase very much afterwards (Figure 5).[9]

The conclusion that yet another doubling of world population is unlikely is most welcome news, but it is still a great reason for concern regarding the future food production. The U.N.'s forecasts actually foresee that the rich world's population in 2050 will be slightly below the 2000 total, which means that virtually all net population growth between 2000 and 2050 will be in today's low-income countries. According to the U.N.'s medium forecast, this global growth would amount to about 3 billion people, surpassing the total of 2.8 billion people added throughout the poor world during the past 50 years. We may be moving toward a stabilized global population faster than anticipated, but the challenge of providing basic existential requirements for the world's poor will become greater, not smaller, in absolute terms.

About 40% of the world's population growth during the next two generations will originate in only a handful of large countries, and at least a third of the total increment will be added in Africa. Among the five countries with the largest population increases, three are in Asia—India (with almost 550 million more people), China (about 220 million), and Pakistan (almost 200 million)—and two are in Africa: Nigeria will add nearly 140 million people and Ethiopia about 110 million.

While some African and Latin American countries may be able to expand their cultivated area—albeit at the price of additional significant loss of tropical forests—worldwide opportunities for a more widespread practice of extensive farming are limited. The need for further intensification of farming will be particularly acute in Asia; with a single exception the continent contains all low-income countries that share or approach China's high dependence on nitrogen fertilizer (Figure 6). These countries have populations larger than 50 million people, and their arable land is limited to less than 0.2 ha/capita. Moreover, losses of farmland to nonagricultural uses and the declining quality of arable land will add to the naturally decreasing per capita availability of cultivable soils.

Besides China (currently with about 0.11 ha/capita), these countries include Bangladesh (0.09 ha/capita), Indonesia (0.12 ha/capita), Pakistan (0.19 ha/capita), the Philippines (0.13 ha/capita), and India (0.18 ha/capita). The non-Asian exception is Egypt, which has a mere 0.05 ha/capita, and in spite of its very intensive cultivation needs high food imports.[10] Inevitably, during the coming decades the global dependence on nitrogen fertilizers would grow even if these countries merely maintained their current average per capita food supply.

That should not be enough. Nationwide means of per capita protein and food energy consumption are above the existential minimal in most low-income countries; in many of them there is hardly any safety margin; and in all of them distribution inequalities mean that protein malnutrition continues to be widespread. Moreover, the future increase of food demand throughout the modernizing world will not be limited merely to satisfying basic nutritional needs of every person.

The desire to eat more animal foods is a universal one, and many studies of long-term trends in the rich countries demonstrate an unmistakable correlation

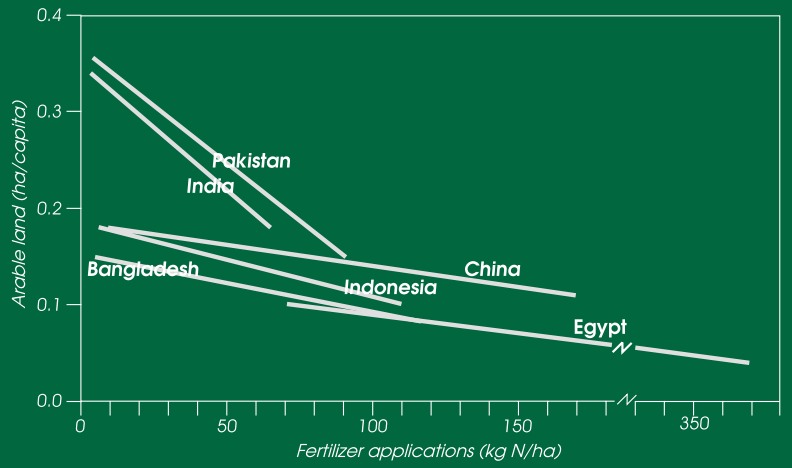


Figure 6. Increasing Dependence on Nitrogen Fertilizer in Land-Scarce Populous Nations, 1960-96.

"When I was born, 85 years ago, the world population was approximately 1.6 billion people. We are now 6.0 billion people. In the next 25 years we will have added 2 billion people—equivalent to the total population of India and China put together. It will not be possible to feed the expected 8 billion in the year 2025 without the use of fertilizers."

—Dr. Norman E. Borlaug,
Nobel Peace Laureate and
IFDC Board Member (from the IFDC video "To Inherit the Earth: A Question of Survival")

"The most significant technical invention of this century is the synthesis of nitrogen fertilizer. And so the best calculations today show that out of 6 billion people on this planet, at least 2.4 billion people depend directly for their basic food for their existence on the synthesis of ammonia, which provides the essential nutrient—nitrogen—for the production of crops which we need for our very existence."

—Dr. Vaclav Smil, Distinguished Professor, University of Manitoba (From the IFDC Video, "To Inherit the Earth: A Question of Survival")

between rising incomes and dietary transitions from high levels of direct consumption of cereals, tubers, and legumes to a rising demand for meat and dairy products. Initial phases of this transition are now clearly noticeable in many relatively better-off, low-income countries. Although the poor world's daily per capita availability of animal protein remains low, it had doubled between 1970 and 1995 and has nearly tripled in China since the beginning of the country's modernization drive in the early 1980s.[11]

Another important consideration that will affect future demand for fertilizer nitrogen is the well-appreciated declining response of crop yields with increasing nutrient applications. Finally, environmental change—ranging from higher concentrations of tropospheric ozone to possibly rapid global warming and from excessive soil erosion to growing regional shortages of water—will further increase the need for intensive, high-yield cropping on the diminishing amount of prime farmland.[12] Quantifying the effects of various forms of environmental pollution and ecosystemic change is extremely uncertain; although there will be some positive effects, it is most likely that the overall impact would be somewhat negative.

A plausible conservative case of the future dependence on the Haber-Bosch synthesis is not difficult to construct. Low-income countries adding 2.9 billion people would have to use 60% more nitrogen fertilizer than they do today merely to maintain their average, and inadequate, diets. Adding 30%-40% to this minimum total to reduce the extent of malnutrition and stunting, to compensate for the declining response to higher applications, and to produce more animal foods would increase their nitrogen fertilizer consumption by as much as 85%. With unchanged food consumption in affluent countries, the world might be using about 125 Mt N in synthetic fertilizers by the year 2050; phosphorus demand rising in tandem would then be between 21 and 22 Mt P/year. A case can be made for higher consumption: Steen's most likely range for the year 2050 is 25-26 Mt P/year.[13]

Slower decline of fertilities in low-income countries, more meaty diets, and the necessity to compensate for the harvest losses due to the environmental change could further raise the dependence on inorganic compounds, but faster demographic transition, more efficient use of fertilizers, and lower food waste could reduce it appreciably. Even more unpredictable, but potentially no less

important, is the impact of future transgenic crops, which might be able to use nitrogen much more efficiently.

In the presence of high concentrations of nitrogen, green alga *Chlorella sorokiniana* competes with bacteria by producing high levels of glutamate dehydrogenase (GDH); the enzyme converts ammonium directly into glutamate, which is then used in a variety of metabolic processes. Transgenic wheat-producing high levels of GDH yielded up to 29% more with the same amount of nitrogen fertilizer than did the normal crop.[14] Other transgenic crops with high GDH capacity are under development, but it is still unclear how and when the private sector will release any commercial cultivars, and, of course, how they will be accepted and how they will perform in field conditions in the long run.

These realities and a rich testimony of notable failures of past long-range forecasts argue against offering any elaborate quantitative predictions. All that we can say with certainty is that our dependence on the Haber-Bosch synthesis of ammonia and on the extraction and treatment of phosphates will rise appreciably during the next two generations, but its actual level will be determined by a complex interplay of our rising, and all too often more wasteful, needs and of our innovative and more efficient uses.

Notes

1. Borlaug, N. 1970. The Green Revolution: Peace and humanity. A speech on the occasion of the awarding of the 1970 Nobel Peace Prize in Oslo, Norway, December 11, 1970. Text at: www.theatlantic.com/atlantic/issues/97jan/borlaug/speech.

2. During the mid-1990s the combined total of all fertilizers used for food and feed cereals was 55% (wheat received 20%, corn 14%, and rice 13% of the total); 12% of all fertilizer went to oil crops, 6% to tubers, 5% to fruits and vegetables, and 4% to sugar crops. Pastures and fodder and silage crops received about 11%, and fiber crops (mainly cotton) no more than 4% of all fertilizer. The remaining 3% included the fertilizing of legumes, cocoa, coffee, tea and tobacco: Harris, G. 1998. *An Analysis of Global Fertilizer Application Rates for Major Crops*. International Fertilizer Industry Association (IFA), Paris (www.fertilizer.org).

3. Smil, V., P. Nachman and T. V. Long, II. 1982. *Energy Analysis in Agriculture: An Application to U.S. Corn Production*. Westview Press, Boulder, CO; Runge, C. F. et al. 1990. *Agricultural Competitiveness, Farm Fertilizer and Chemical Use, and Environmental Quality: A Descriptive Analysis*. Center for International Food and Agricultural Policy, Minneapolis, MN.

4. Smil, V. 1999. N*itrogen in China's Agriculture: An Unorthodox View of History*. Paper prepared for the Stanford's Center for East Asian Studies.
5. Smil, V. 1999. Nitrogen in crop production: An account of global flows. *Global Biogeochemical Cycles*, 13:647-662.
6. Food and Agriculture Organization of the United Nations (FAO). 1999. *Food Balance Sheets*. (http://apps.fao.org).
7. FAO. 1996. *The Sixth World Food Survey*. FAO, Rome.
8. In contrast to their high N share, low-income countries now account for less than 60% of global applications of phosphorus and for less than 40% of all potassium.
9. United Nations. 1998. *World Population Prospects: The 1998 Revision*. UN, New York.
10. I am using official farmland figures for all countries except for China, where I use the considerably higher revised total: Smil, V. 1999. China's agricultural land. *The China Quarterly,* 158:414-429.
11. The actual multiple may be smaller due to exaggerated reporting of meat production in China's official statistics.
12. Many recent volumes have examined the likely effects of large-scale environmental change on agriculture, including: Rosenzweig, C. and D. Hillel. 1997. *Climate Change and the Global Harvest: Potential Impact of the Greenhouse Effect on Agriculture*. Oxford University Press. New York; F. Bazzaz and W. Sombroek. 1996. *Global Climate Change and Agricultural Production*. John Wiley, New York; Kimble, J. et al., eds. 1995. *Soils and Global Change*. CRC Press, Boca Raton, FL.
13. Steen, I. 1998. Phosphorus availability in the 21st century. *Phosphorus & Potassium*, 217(5):25-31.
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Introduction

During 1999 IFDC celebrated its 25th anniversary; over the past quarter century, the Center has accumulated many achievements as it seeks ways to enable farmers throughout the world to raise their yields. Since its launching in 1974 during a global food crisis, IFDC has played a singular role in furthering the goals of the Green Revolution, which was just getting started in Asia and Latin America. From its Headquarters and offices located around the world—in Albania, Bangladesh, Ecuador, Kenya, Kosovo, Mozambique, Niger, Togo, and Uruguay—IFDC is making a difference in the lives of people through its programs in research and development, technology transfer, and human resource development. As evidenced in the following "Highlights," IFDC's activities during 1999 met several objectives. These activities served to increase small-holder access to improved agricultural inputs, improve and expand private-sector agribusiness, provide technical advice to developing-country partners, engage and collaborate with the private sector, take international leadership roles in addressing African soil nutrient issues, and pursue the development of new technologies.

Increase Small-Holder Access to Improved Agricultural Inputs

- With funding from USAID, the Agrobased Industries and Technology Development Project (ATDP) in Bangladesh clearly showed the results of entrepreneurial spirit and convinced the Government and budding agribusinessmen that Bangladesh has a future in value-added agribusiness. The eight subsectors that are addressed by this project are fertilizer, seed and field crops, horticulture, poultry, livestock, fisheries, processing of agricultural products, agricultural machinery, and agricultural processing equipment. Throughout the project, 600,000 farmers increased their incomes by using more productive, environmentally sound technologies, primarily urea supergranules (USG). One hundred and sixty-five contract grower/pilot zones were initiated with private business investments. The ATDP has spurred US $250 million in credit and investments by private businesses in the agricultural and agribusiness sector. The ATDP project spearheaded 50 policy reforms to facilitate agribusiness growth. At ATDP's request, the government restructured 26 rates of customs duty, infrastructure development surcharge, and value-added tax covering a wide range of raw and packaging materials related to agribusiness. The government's policy documents such as the budget statement and the industrial policy now recognize the importance of agribusiness.

Highlights of IFDC's Achievements During 1999

Dr. Thomas P. Thompson, IFDC Senior Specialist, Human Resource Development, participates in a USG field day and harvesting program in a Bangladesh village.

A Bangladesh woman receives hybrid papaya seedlings from an officer of the Bangladesh Rural Advancement Committee during an ATDP training course.

Albanian fertilizer dealers were provided credit lines totaling US $1.85 million for fertilizer importation at a time when the state banking system had collapsed. Fertilizer importation into Albania continues to increase.

- ATDP forged ahead in technology introduction and commercialization. For example, ATDP's promotion of the technology for USG deep placement improved rice cultivation in Bangladesh. Under flooded rice cultivation this technology is more efficient and, given the availability and cost of labor in Bangladesh, it is more cost effective than traditional methods of applying urea. The increase in crop production, using less fertilizer, meant 57% higher net returns for rice farmers who used this technology.
- Our staff in Albania assisted input dealers in establishing Technology Transfer Centers and a private sector extension service that provides 75% of the 400,000 small-holder farmers with access to more productive technologies.
- Innovative new pilot programs, such as Farmers for the Future, are generating integrated nutrient management packages that can help sub-Saharan African countries tackle their daunting food security challenges.

Improve and Expand Private Sector Agribusiness

- In the Government of Bangladesh budget that began in July 1999, IFDC helped bring about the reduction of tariffs in 25 categories related to agribusiness. These augment the significant removal during 1998 of policies restricting growth of private business.
- The IFDC-initiated trade association of input dealers in Albania became self-sustaining in 1999. The new project begun in January works directly and through trade associations with emerging agribusinessmen and has already realized $6 million in new investments.
- The IFDC project in Bangladesh during 1999 has enabled farmers for the first time to export potatoes, boosted shrimp exports to $18 million, and doubled local poultry production.

Farmers in sub-Saharan Africa are benefiting from integrated nutrient management packages being developed by IFDC-Africa.

- IFDC training and study programs have exposed over 1,000 entrepreneurs, decisionmakers and researchers to better business skills, analytical techniques, and marketing know-how.
- With Dutch funding, the IFDC-African Fertilizer Trade and Marketing Information Network Program promoted market transparency by providing bi-weekly reports on regional/global fertilizer market conditions for private and government officials in 95% of sub-Saharan African countries.
- An IFDC agribusiness specialist, stationed in the Ukraine and working in concert with the Citizens' Network for Foreign Affairs, helped stimulate contracts for seven agribusiness projects that leveraged US $24 million in foreign investment for the development of agricultural entrepreneurship.

Provide Technical Advice to Developing-Country Partners

- In collaboration with Sasakawa Global 2000, the IFDC/SG 2000 team conducted country studies that identified critical constraints to the development of the fertilizer market in Uganda and Tanzania and suggested policy-related, organizational, and institutional measures to alleviate these constraints. The Uganda study was partially funded by USAID/Uganda. Staff members interacted with policy makers, farmers, private-sector dealers, donors, and nongovernmental organizations, and completed the study reports. A special session was held with the Prime Minister Frederick Sumaye of Tanzania.
- These country studies also paid particular attention to the management of donor-funded fertilizers, such as the commodity grants under the Second Kennedy Round (KR2) from Japan. Constructive discussions were held with the Japanese officials in Japan, Uganda, and Tanzania to improve the management of grant fertilizers and counterpart funds.
- IFDC negotiated a long-term project to reform the KR2 program in Mozambique and also develop a fertilizer regulatory system for the country.
- Our staff members in Albania provided advice and forward thinking on assisting the Kosovo refugees in re-establishing their crop production. We have proposed ways for Kosovars to collaborate with the successful private sector agribusiness in Albania.

Dr. Upendra Singh, IFDC Senior Systems Modeling Scientist, assists a participant in applying a simulation model to a cropping system during a hands-on session in the training program on "Computer Simulation of Crop Growth and Management Responses."

Dr. Kofi Debrah, IFDC-Africa Policy Economist, meets with a group of African farmers to learn more about the constraints to African agriculture from the small farmer's perspective.

Members of the IFDC/SG2000 team, Dr. Balu L. Bumb (left), IFDC Senior Economist, and Daniel Kikoyo (far right), an official with the Ugandan Ministry of Agriculture, discuss the issues related to farm input supply in Uganda with employees of the Masaka Farm Input Supply Store in Masaka, Uganda.

IFDC's Outreach Division Director, Jorge R. Polo, addresses an international workshop on current environmental issues of fertilizer production, held in Prague, Czech Republic.

- IFDC fielded a team of specialists in Kosovo to assess the inputs and agribusiness sectors to develop an action plan to spur growth of these sectors through active participation of the entrepreneurs.
- Two IFDC staff members participated in a round table conference on the "Consequences of the Uruguay Round Agreement (URA) for Bangladesh Agriculture" in Dhaka, Bangladesh. The team reported on an ATDP/IFDC-conducted study that focused on seven commodity groups and analyzed the implications of the URA and other related agreements for agriculture and agribusiness development in Bangladesh. Because Bangladesh has liberalized its foreign trade at a faster pace than what is implied by the URA, Bangladesh's URA commitments on tariffs are unlikely to have any significant impact on its trade; actual (operating) tariffs for most commodities are much lower than bound tariffs. The team made two sets of policy and technical recommendations. The first set included recommendations for the multilateral trade negotiations in Seattle, Washington in November 1999, and the second set focused on the recommendations for the government of Bangladesh to promote agriculture and agribusiness in the country. The government of Bangladesh is reviewing these recommendations for implementation.

Engage and Collaborate With the Private Sector

- On a full-cost recovery basis, IFDC assisted at least 12 developing countries including Mexico, Malaysia, Cameroon, and Venezuela to technically improve their fertilizer production and distribution activities so that appropriate fertilizers would reach small-holder producers when they need it.
- IFDC organized a successful workshop in Prague in June 1999, which assembled fertilizer industry representatives from the region to evaluate environmental issues related to the production and trade of fertilizer. The workshop advanced the objectives of promoting energy efficiency and environmental technologies in the region.

Take International Leadership Roles in Addressing African Soil Nutrient Issues

- IFDC designed a strategic framework that will assist governments, donors, and other stakeholders in addressing the complex issues of making agricultural inputs more accessible to small farmers in sub-Saharan Africa. In collaboration with the United Nations Economic Commission for Africa (ECA), IFDC hosted a workshop in Ethiopia in July 1999 to validate the draft findings. Over 70 stakeholders attended, including representatives from the private sector and donor community. The strategic framework will assist stakeholders as they design interventions (policies and programs) to support or induce private-sector based action to increase access to and use of agricultural inputs.

- The overall objective of IFA- and USAID-funded activities is to increase food security in West Africa through the promotion and extension of integrated soil fertility management technologies. In collaboration with NARS and NGOs, the project is carried out in different agroecological zones: coastal savanna (Benin and Togo), northern Guinean savanna (Ghana, Nigeria, and Togo), and Sudanian savanna and Sudano-Sahelian zone in Burkina Faso and Niger. Integrated packages, based on soil amendments and mineral fertilizers, are developed. Significant attention is given to a participatory approach to institutional development (farmer organizations, improving access to input and product markets, credit systems). Farmers have shown much interest, and some important results have already been obtained. For instance, in Benin, farmers were able to increase maize yields to 3, and sometimes even to 4 t/ha, when compared with 0.4-1.0 t/ha yield with no external inputs. Positive results were also reported in southern Togo, where farmers were able to produce 5-6 t/ha of rice while normally they only produce 1.5-4 t/ha. IFDC is attempting to consolidate and scale up these achievements by facilitating exchanges between farmers, traders, extension agents, and other stakeholders.

- IFDC leads a project focusing on soil fertility management and restoration, which is supported by the International Fund for Agricultural Development (IFAD). IFDC collaborators intervened in southern Togo, northern Togo, Ghana and at two locations in Niger. Two partner institutes, Tropical Soil Biology and Fertility Programme (TSBF) and the African Centre for Fertilizer Development (ACFD), conducted fieldwork in Malawi, Zambia, and Zimbabwe. At all of these

Workers on the farm of Augustin Atiye prepare land for planting. This Togolese farmer harvested 400 kg more maize after applying a maize-mucuna system on his small plot during the past 2 years.

Dr. Henk Breman, Director, IFDC-Africa, and an African scientist examine soil—the basis of all forms of life.

"Being myself a Green, being an ecologist, I realize that the simple message of not using fertilizer is a dangerous one. At this very moment, even in good areas of Africa, most of farmers' revenue is obtained by mining the soil. That is not sustainable at all. Others say that African farmers should use only organic fertilizers. The soil fertility problem cannot be solved with just organic fertilizer because there is not enough organic fertilizer. If agriculture continues to stagnate... ...as population grows, hunger or even famine in the countryside is inevitable, and it will force mass migration to the already teeming cities. There will be wild urbanization. There will be no control possible on migration to cities. Not only the African environment, but also the global environment will be influenced."

—Dr. Henk Breman,
Director, IFDC-Africa (From the IFDC video,
"To Inherit the Earth: A Question of Survival")

locations of onfarm experiments, the effect of soil fertility improvement on the agronomic efficiency of mineral fertilizers was studied. The extent to which soil fertility can be improved depends on the local conditions. For example, in southern Togo a maize/mucuna association was tested while in northern Togo compost was used for improving the soil organic matter status. During 1999 special attention was paid to the socioeconomic conditions in the different regions in relation to the proposed packages.

- IFDC published a report in May 1999 that demonstrates the alarming rates of nutrient depletion in Africa and highlights the scope of the problem and urgency of response required from the international community.
- Assisted by IFDC-Africa, Burkina Faso was the second African country (after Ghana in 1998) that adopted a soil fertility improvement national action plan. In Guinea IFDC assisted the World Bank and FAO in their support to the government for the preparation of such a plan.
- Since September 1998, an IFDC senior soil fertility scientist has been assigned to the regional office of the Centro Internacional de Mejoramiento de Maiz y Trigo (CIMMYT) in Nairobi, Kenya, as the jointly appointed Regional Maize Systems Specialist. The Maize Systems Specialist is assisting CIMMYT in implementing and executing projects in crop management research and control of the parasitic weed, *Striga hermonthica*, in maize in the eastern and central Africa region. He has responsibility for the maize component of the CIMMYT East Africa Cereals Program (EACP), funded by the Canadian International Development Agency (CIDA), which is the founding project of the East and Central Africa Maize and Wheat (ECAMAW) network.
- One of the principal activities of this project is to provide technical oversight to a small grants program that funds research proposals from national agricultural research system (NARS) scientists to address abiotic and biotic constraints to maize production in the region. Soil fertility enhancement including green manures receives the main portion of support from the EACP small grants program, which also funds studies in soil and water conservation, weed control, post-harvest losses, among others. In 1999, the portfolio of maize projects consisted of a total of 23 on-station experiments and 122 on-farm trials. On-farm trials were a mixture of researcher-managed and farmer-managed trials. Priorities in soil fertility research for the ECAMAW network were discussed in a workshop organized by the Maize Systems Specialist in

November 1998, in Mombasa. The EACP sponsored a training course on the "Statistical and Economic Analysis of Nutrient Response Trials," in which IFDC played a major role. The Maize Systems Specialist also represents CIMMYT (and unofficially IFDC) on the Africa Highland Initiative and the Systemwide Livestock Program. Recently, he has become involved in supporting the use of simulation models in the region through participation in an Ecoregional Fund Project awarded to the Agricultural Research Council and CIMMYT, which will provide small grants to scientists in the region to support their modeling activities. Many of these scientists had previously received training in the use of the Decision Support Systems for Agro-Technology Transfer (DSSAT) models through IFDC training courses.

- Along with TSBF, IFDC is a co-convenor of the Combating Nutrient Depletion Consortium (CNDC), under the Soil, Water, and Nutrient Management Program of the Consultative Group on International Agricultural Research (CGIAR). The focus of CNDC in West African savannas is to develop and use systems tools that synthesize available information on soil, water, and nutrient management and make it accessible to a range of clients for decision making. Ex-ante analyses of soil and climate from four representative sites from the Northern Guinea Savanna and Coastal-Degraded Savanna clearly showed nutrients and not water as the key constraint for the current yield-gap. A common finding at both benchmark sites was that a moderate addition of N fertilizer increased net return and decreased risk associated with year-to-year variability in weather and prices. During 1999 field trials to quantify nutrient dynamics in a maize-based cropping system (maize, cowpea, cotton, and cassava) were conducted in collaboration with the Institute of Agricultural Research (IAR), Nigeria, and the Institut National de Recherches Agricoles du Benin (INRAB), Benin.
- A Client-Oriented Systems Tool Box for technology transfer related to soil fertility improvement and sustainable agriculture in West Africa (COST Box) Project was launched during 1999 with financing from the Ecoregional Fund and support from the Agricultural University of Wageningen. At the invitation of the Ecoregional Program for the Humid and Subhumid Tropics of Sub-Saharan Africa (EPHTA), IFDC and the International Institute for Tropical Agriculture (IITA) co-organized a method-

"We've got 800 million chronically malnourished people in the world, and we'll have about 1.6 billion more by 2020. That's over two billion more mouths to feed if everyone's going to have a decent life. We're going to need two approaches to do this. One is ecologally sound agriculture. The other is biotechnology."

—Dr. Gordon Conway, President of the Rockefeller Foundation

Dr. André M. Bationo (right), Senior Soil Fertility Scientist, discusses with Dr. Amit H. Roy, IFDC President and Chief Executive Officer, the IFDC/ICRISAT project being conducted in Niger to help solve the food production problems in SSA.

ologies harmonization workshop. Harmonization of methodologies is essential in ecoregional projects to reach common goals and to obtain the synergism of ecoregional cooperation. Such harmonization will enhance effective introduction of COST Box products and approaches in the region.

- An IFDC senior soil fertility scientist, stationed at the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Sahelian Center, in Niamey, Niger, is conducting research that is providing valuable information to help solve food production problems in sub-Saharan Africa. For the past few years this research has emphasized testing and validating experiment-station-developed technologies under on-farm, farmer-managed trials. Four representative sites that account for differences in agroecological and socio-economic conditions of the Sudano-Sahelian zone have been selected for this purpose. One hundred and twenty farmers are participating and testing those technologies on about 1,000 plots. An important outcome is that mineral fertilizer efficiency is increased drastically when the soil is improved through the amendments of crop residues, manure, phosphate rock, and rotation of cereals with legumes. An ICRISAT economist is currently assessing farmers' preferences for the tested technologies and conducting an economic evaluation of these technologies. Credit is a constraint for the farmers participating in these experiments. Therefore, close links were established with a Food and Agriculture Organization of the United Nations (FAO) project and nongovernmental organizations (NGOs) to establish a good credit system to enable farmers to have access to external inputs.

Pursue Development of New Technologies

- Canola is a high-value crop mainly used for producing cooking oil. Recent IFDC research shows that direct application of medium- to high-reactive phosphate rock is 60%-80% as effective on alkaline and neutral soils as high-cost, water-soluble fertilizers. This is significant because it allows smallholder farmers in the Middle East to use low-cost phosphate rocks that are found in abundance in most countries of the region to produce canola competitively.
- With funding support from the Thrasher Research Fund, IFDC scientists are conducting a research project entitled "Potential Use of Iron Phosphate Fertilizers to Enrich Iron Nutrition in Food Crops Grown on Alkaline Soils in Developing Countries." The project's objective is to increase the iron nutri-

tion of cereal crops by using iron-rich phosphate fertilizers in alkaline soils. The project is using seeds of low phytic acid genotypes of barley and rice from the U.S. Department of Agriculture-Agricultural Research Service and also iron-efficient seeds from IRRI.

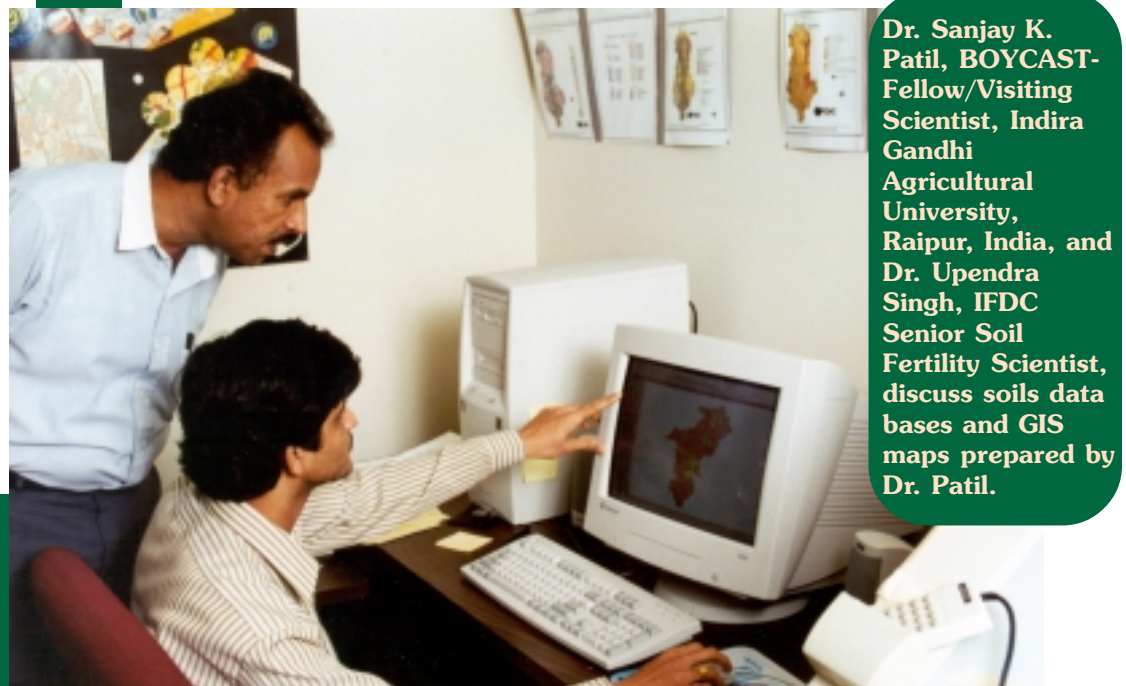
- IFDC continued to participate in a project sponsored by the FAO and the International Atomic Energy Agency (IAEA), Division of Nuclear Techniques in Food and Agriculture. As part of the research program on "The Use of Nuclear and Related Techniques for Evaluating the Agronomic Effectiveness of Phosphate Fertilizers, in Particular, Rock Phosphates," IFDC has conducted three primary greenhouse experiments to meet part of the objectives of this program. In addition, IFDC also coordinated the collection of minimum data sets by the collaborators from developing countries for testing the phosphorus submodel in crop simulation work.
- At Headquarters IFDC scientists and a visiting Brazilian scientist found that acidulated phosphate fertilizers produced in Brazil with low water-soluble phosphorus content can be agronomically effective for upland and flooded rice. This finding is significant in terms of cost saving to the fertilizer industry and farmers in Brazil.
- IFDC scientists have been studying the effect of different nitrogen fertilizers on soil acidification in a 3-year greenhouse experiment with wheat and maize as rotating crops. This work is being conducted on a contract basis for a private company.
- An IFDC scientist is working with the NARS in Brazil, Argentina, Uruguay, and Paraguay on nutrient management and the development and application of crop simulation models and Decision Support Systems (DSS). In response to renewed interest, these models are being used to assess the effect of global climate change on agricultural productivity. IFDC staff members are working closely with the National Oceanic and Atmospheric Agency (NOAA) in the validation of these models.
- With partial funding from the Empresa Brasileira de Pesquisa Agropecuaria (EMBRAPA), IFDC continued work on the application of decision support systems and crop simulation modeling in Brazil. In collaboration with the Ministry of Agriculture of the State of Parana, Brazil and with their financial support, an IFDC scientist is developing an Information and Decision Support System (IDSS) for that state to use in decision making and for forecasting purposes (crop yields

Dr. Sen H. Chien, IFDC Senior Soil Chemist, and Dr. Luis Prochnow, Visiting Scientist, discuss the use of phosphate fertilizer in rice production.

Dr. Walter E. Baethgen (right), IFDC Soil Fertility/Biometrics Scientist, stationed in Uruguay, confers with Dr. Agustin F. Gimenez, Head of the National Research Program (Summer and Oil Crops) of the National Agricultural Research Institute (INIA), Uruguay.

and the effects of El Niño). The IFDC scientist posted in Uruguay is collaborating with IAEA on a project concerning nitrogen use efficiency by irrigated wheat involving the calibration of the CERES-Wheat Model with data from contrasting environments (Africa, Europe, Asia, Latin America). An objective of this project is to better use the model as a tool for improving recommendations for nitrogen fertilizer use on irrigated wheat.

- As a contribution to the World Resources Institutes' special millennium publication on the State of Global Ecosystems, IFDC in collaboration with the International Food Policy Research Institute (IFPRI) has completed a preliminary estimate of plant nutrient fluxes and balances in Latin America. This information will be used to develop strategies to prevent nutrient depletion and land degradation in Latin America.
- An IFDC scientist, stationed at the Centro Internacional de la Papa (CIP) in Peru, is developing and implementing integrated assessment models that help stakeholders better understand the complexity of issues related to agricultural and environmental interactions in mountain communities. Partners in this effort include national agricultural research systems, nongovernmental organizations, and universities in Peru, Ecuador, U.S.A., and the Netherlands.
- At Headquarters IFDC scientists and a Better Opportunity for Young Scientists in Chosen Areas of Science and Technology (BOYSCAST)



Dr. Sanjay K. Patil, BOYCAST-Fellow/Visiting Scientist, Indira Gandhi Agricultural University, Raipur, India, and Dr. Upendra Singh, IFDC Senior Soil Fertility Scientist, discuss soils data bases and GIS maps prepared by Dr. Patil.

Fellow/Visiting Scientist developed an Integrated Decision Support Toolbox (IDST) for the rainfed lowland of Chattisgarh Region of India. The toolbox delineates suitable areas for wet and dry season cropping, estimates crop nutrient requirements, and identifies current yield-gaps.

- An Indian Visiting Scientist has calibrated and validated CERES-Rice, CERES-Wheat and CERES-Maize models using minimum data sets generated from IFDC/IRRI/Indira Gandhi Agricultural University (IGAU) field studies conducted in India. A spatial soil and long-term climatic database for use with crop simulation models for yield forecasting and decision making was also developed.
- An IFDC/IRRI/IGAU field study has revealed that residual N use efficiency can be improved by adopting a dry direct-seeding system of rice cultivation. The accumulated nitrate-N from the dry season is used by direct-seeded rice while much of this N is lost during the puddling of fields for transplanted rice. The significance of N loss from the rice crop during the flowering to maturity stages under a water stress condition was also observed in the study. The poor N recoveries associated with rainfed rice could also be attributed to N losses from the plant. This study points out that the N accumulated at harvest does not necessarily represent the maximum N accumulated by the rice crop and thus the recoveries normally calculated at harvest do not correctly reflect the fertilizer recovery efficiency. This research finding can lead to plant breeders developing more improved crop varieties that have lower N losses from the plant.

"This (IFDC) research finding can lead to plant breeders developing more improved crop varieties that have lower N losses from the plant."

—Dr. Upendra Singh,
IFDC Senior Systems Modeling Scientist

Paving Pathways to Progress Via Agribusiness, Research, and Training

In the pages that follow are real-life accounts of people whose quality of life has been improved by the work of IFDC's researchers and specialists in agribusiness and human resource development. The feature stories relate the experiences of entrepreneurs, farmers, scientists, and others in countries like Albania, Bangladesh, Brazil, Kosovo, Malawi, and Togo.

Putting Money in the Pockets of Farmers and Shop Owners

Project in Albania Advances That Country's Economic Growth

With only 1,000 square meters of land and a small greenhouse, Shefki Haxhiu—one of Albania's farmers—managed to save enough money from the sale of his tomatoes and cucumbers to expand his greenhouse. With the rest of his earnings he transformed his father's piece of hilly land into a vineyard for growing grapes and olive trees. He doubled his harvest of grapes in three years and expects to harvest about five times as much in 2000 (5,000 kg).

Albanian farmer Shefki Haxhiu has benefited from the IFDC project in his country. Through IFDC television programs, he learned how and where to purchase the best inputs. The project publications taught him how to boost the productivity of his grape vineyard and olive trees.

An agricultural inputs dealer—Engjell Jazxhi—faced a difficult decision in 1991 when all the cooperative farms collapsed along with the old Albanian regime. He could either escape to a possibly better life in Greece or stay and build a new life and business in the emerging free market economy of Albania. Jazxhi chose the latter option. Using a US $300 inheritance as seed money to secure loans, he purchased 22 mt of fertilizer and began his own small dealership. Jazxhi was very successful in distributing and selling fertilizer in five villages in his area covering seven retailers in eastern Albania. After attending IFDC training seminars, he diversified his business into other agricultural inputs, including seeds. Because of his service to farmers and business ethics, he has built a solid reputation and significantly expanded his business, which now includes 80 sub-dealers, 8 large warehouses, and 40 smaller sales points. Jazxhi's turnover in 1999 far exceeded US $1 million, with one-half of his business in seeds.

"The success of AFADA really is the untold story of success in the Balkans, overcoming all of the instability and the upheavals. During the past decade, agricultural production in Albania has grown by over 7% each year. Wheat and maize yields have doubled. Maize has increased in yield from 2.9 tons per hectare in 1996 to 3.7 tons per hectare in 1999. When you organize the private sector, you unleash an untold array of innovation and drive that provides the inputs and technical know-how for a country's agricultural sector."

—Ian Gregory, Coordinator, IFDC Agribusiness Program (From the IFDC video, "To Inherit the Earth: A Question of Survival")

Haxhiu, Jazxhi, and thousands of other Albanian farmers and entrepreneurs have benefited from a recently completed project sponsored by USAID and conducted by IFDC. The project entitled "Sustaining the Restructured Fertilizer Sub-Sector in Albania" was described as "most successful in developing agriculture in Albania" by the U.S. Ambassador to Albania, the Honorable Joseph Limprecht. "The project fulfilled all of its goals in ensuring a reliable supply of seed and fertilizer through the private sector and provided a valuable example of using credit," he said.

"Through IFDC-Albania television programs, I learned how and where to buy the best inputs," farmer Haxhiu says. "IFDC-Albania publications taught me how and when to use fertilizers, such as urea and single superphosphate, on my olive trees to boost production. By using this information I was able to almost quadruple my harvest per tree, from 4 kg in 1993 to 15 kg in 1999."

The project was started in October 1995 and aimed to build on the previous work of IFDC in establishing an effective private market to supply farm inputs for Albanian farmers. The achievements of the project gained the praises of the Albanian Minister of Agriculture for "establishing a private-sector system to supply agricultural inputs and providing a model for the development of the agribusiness sector."

A new IFDC publication entitled *Sustaining the Restructured Fertilizer Sub-Sector in Albania: A Private-Sector Success*, highlights some of the project's most outstanding accomplishments. Topping the list of achievements is "development of a working and vibrant agricultural input market." Fertilizer imports rose from 32,000 mt in 1995 to an average of 75,000 mt in 1998 and 1999. Private enterprises now supply 100% of national fertilizer requirements, 95% of the crop protection chemicals (CPC), and 80% of the certified imported and domestic seed. Private dealers now independently finance 74% of their imports and use supplier credits rather than institutional loans.

As a result of the project, Albanian farmers now produce 5,000 mt of certified seed. The seed industry was resurrected from a US $18,500 business in certified seed in 1995 to a US $3.8 million business in 1999.

Because of the USAID/IFDC intervention, about 20% of Albania's farmers are now using modern agricultural inputs. Their yields of maize have increased by more than 70% since the project's beginning.

With the strengthening of the Albanian Fertilizer and Agribusiness Dealers Association (AFADA), the dealer organization gained financial independence in January 1999. Its membership of 125 dealers now has assets of US $100,000 and a reputable public image. Business turnover for AFADA members during 1999 amounted to US $23 million.

Improved fertilizer and seed laws and the reduction in tariffs and other impediments to agricultural input and agribusiness development are other accomplishments of the project.

According to the Albania project's Chief of Party, Claude Freeman, the widely recognized successes of the project include:

- The creation of seven new agriculture-based trade associations similar to AFADA.
- A model for democratic, effective trade association-based agribusiness development.
- Private field demonstrations and extension services that deliver practical technology.
- The vital role and possibilities for credit to fuel agribusiness growth.
- Appreciation of the value of generating customer trust and using mass media.

"This project has clearly shown that private-sector agribusiness can function in Albania," says the Coordinator of IFDC's Agribusiness Program, Ian Gregory. "IFDC intends to reinforce these efforts in Albania and Kosovo and to work with the donor commmunity to bring about similar successes in other countries and regions."

"AFADA is not only the basis for Albania's modern, competitive agricultural economy, but it provides the foundation for Albania's faith in the free market. Its impact spreads far beyond agriculture itself and will influence growth throughout the economy."

—U.S. Ambassador to Albania, December 9, 1999)

Growing Albanian Agribusinesses

New Trade Association Project in Albania Exceeds Investment Goals

In January 1999, IFDC began implementing a new project in Albania whose aims are to develop private agribusiness, strengthen agricultural trade associations, and expand agribusiness access to credit and finance.

USAID provided US $6 million for three years, with an option for two additional years for the project called "Assistance to Albanian Agricultural Trade Associations (AAATA). IFDC and its partners—Mississippi State University, the Albanian-America Trade and Development Association, and an Albanian savings and credit nongovernmental organization—agreed to stimulate investments and contributions worth an extra US $4 million.

During its first year, the project helped generate over US $6 million in self-investments, commercial financing, association dues, and other shared costs. Thus, despite the chaos of the Kosovo conflict and continued uncertainty in the business climate, the project in its first year was able to exceed the total three-year target. The staff provided the technical assistance and support mechanisms that encouraged their private agribusiness clients to venture forward despite the risks. The entire country has reaped the rewards.

AAATA evolved naturally from the successful work by the USAID/IFDC partnership in Albania that began in late 1991 following the collapse of nearly 50 years of totalitarian Communist rule. IFDC pioneered the establishment of an efficient private-sector distribution network for vital agricultural inputs to fill the vacuum. The solid growth of AFADA and its success in obtaining access to credit, in serving the farm community, and in stimulating agricultural enterprises led USAID to conceive the successor AAATA project.

In addition to agribusiness development, fostering trade associations, and finance availability, the AAATA project also:

- Provides technical assistance and equipment to two Albanian government institutions that deal with food quality and safety—the Food and the Veterinary Research Institutes,
- Establishes credit unions anchored in agricultural trade associations, and
- Develops media impact and lasting capabilities that serve all of the above components.

Some of the accomplishments in the first year of the project include:

- Intensively counseled 29 target client firms and helped prepare 20 business plans.

- Helped clients in 1999 obtain US $1.2 million in commercial loans and US $1.8 million in trade credits and stimulate US $2.8 million in new self-investments in equipment.
- Doubled paying membership in the associations, whose members account for 75% of their respective industries. Dues and cost sharing by members exceeded US $240,000.
- Created an apex organization of 13 agricultural trade associations that increasingly demonstrates the ability to influence the reform of policies affecting business.
- Assisted all seven client trade associations in holding general and regional meetings, expanding member services, creating media placements, and strengthening leadership.
- Produced a quarterly magazine that is the primary source of information on agribusiness.
- Increased international business connections for the seven client trade associations, with attendant growth in trade, by organizing 20 trade missions and other events.
- Established an expert advisory council of Albanian agricultural specialists.
- Collaborated with the American Bank of Albania, which has become a progressive leader in offering credit to agricultural entrepreneurs.
- Fostered a functioning credit union among AFADA members. Savings increased by 55% during the second half of the year to 2.3 million leks (US $16,000).
- Worked with other partners, e.g., Volunteers in Overseas Cooperative Assistance (VOCA), Land O'Lakes and the Irish Credit Union.
- Provided help and established links with Kosovo refugees in Albania.
- Used the media to spread consumer quality and safety awareness and imaging in food.
- Organized workshops and client site visits on food quality by institute specialists.
- Stimulated free media coverage valued at US $35,000 for a score of AAATA events.

"If it's well structured and sequenced, trade liberalization can be an engine of development and poverty reduction. . . . If liberalization is to deliver its potential benefits, governments need to take, and external partners need to support, a range of complementary action in areas such as infrastructure upgrading, governance and institutional reform, and social investment in, e.g., education and health care."

—James D. Wolfensohn, President, The World Bank Group

Fertilizer Pellets With Punch

Urea Supergranules Translate Into Increased Yields and Greater Profits for Bangladeshi Farmers

Belayet Hossain, a Bangladeshi rice farmer, has hope for a brighter tomorrow for his family, thanks to a fertilizer that has been introduced in his country by a project sponsored by USAID and the Government of Bangladesh. By placing this fertilizer—urea supergranules or USG—into the soil, Hossain and other Bangladeshi farmers are increasing their rice yields by more than 25% and realizing more than 50% greater profits. With this environmentally sound fertilizer, losses of nitrogen amount to only 30%, compared with 70% for the traditionally used prilled urea, which is broadcast over the fields. This translates into an extra profit of TK 1,200 (US $24.33) per hectare.

In Hossain's village of Rathuri in the Tangail District, verdant fields of lush, healthy rice plants stretch to the horizon. In this predominantly rice-growing district, scores of farmers like Hossain trek to their fields with plows on their shoulders in the early morning. On farm demonstration day, all the farmers gather to admire the 40 ha of demonstration plots where 237 farmers have transplanted rice and placed 2 to 3 small white tablets called USG between the rice plants. These briquettes are produced in small machines within villages. Now they are pleased to see more and healthier rice plants in the plots.

Looking at the larger picture, Bangladesh is at a crossroads in its quest for economic and social development. According to the World Bank some social indicators, such as birth rates and life expectancy, have improved remarkably since the country's independence in 1971, but economic growth has been slow to reduce poverty substantially. Bangladesh is one of the world's poorest countries with a per capita income of US $180 per year. Average per capita gross national product (GNP) of the 130 million population was only about $270 in 1997, with nearly 37% of the population living below the poverty line for the "very poor" and 53% below the poverty line for the "poor." It is also one of the most densely populated countries with an average of 733 people per square kilometer. Bangladesh has one of the highest rates of malnutrition in South Asia with 9 out of 10 children malnourished to some degree. With 75% of Bangladesh's 50 million work force engaged

in agriculture and more than half of its population living below the poverty line, no growth and poverty alleviation strategy can succeed without growth and prosperity in the agriculture sector.

The ATDP, managed by IFDC, has been highly successful in improving rice cultivation in Bangladesh using USG technology and represents a model of public/private-sector cooperation. This project is resulting in benefits for Bangladesh's rice farmers and the agribusiness sector. In the production of rice, Bangladesh's most important field crop, nitrogen is the key nutrient and urea is the primary nitrogenous fertilizer used. However, urea is costly, with some 70% often wasted because of the commonly used application technique of broadcasting the fertilizer in prilled form. USG deep-placement technology is a far more efficient and cost-effective alternative. This technology involves briquetting (pressing) urea into one-gram marble-sized briquettes and placing these granules at a depth of 5-7 cm when the rice plants are transplanted.

With the cooperation of a private entrepreneur and the Government of Bangladesh and the support of USAID, the ATDP introduced USG technology in Bangladesh in a commercial context in 1996. Since then USG demonstrations have been conducted in various regions of the country in cooperation with the Department of Agricultural Extension of the Ministry of Agriculture, the Bangladesh Rural Advancement Committee, and other nongovernmental organizations (NGOs). The Department of Agricultural Extension has been instrumental in introducing and promoting USG technology.

To facilitate the adoption and use of this improved, environmentally sound technology, the ATDP project has supported the development of USG manufacture in Bangladesh by encouraging machine shops to design and produce low-cost USG briquetting machines and by assisting entrepreneurs in the establishment of businesses for USG production and marketing. The reported progressive sale of briquetting machines through June 1997 was 2; June 1998, 20; and June 1999, 212. 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 provide for the allotments of urea from factories to USG manufacturers at factory prices and free movement of USG to markets anywhere in the country. Before these two policy decisions were made, only government-appointed dealers were allowed to purchase fertilizer from factories, and the dealers could only sell in restricted areas.

"The process of development is not primarily concerned with expanding supply of goods and services but more of enhancing the capabilities of people. There is a need to pay specific attention to the generation and security of entitlements and their conversion into capabilities."

—Amartya Sen
1998 Recipient of Nobel Prize for Economics

"Breaking the Cycle of Poverty and Hunger"

The area of Bangladesh land under USG technology has expanded from 2 ha in 1996 to 600 ha in 1997 to over 10,000 ha in 1998 to over 100,000 ha in 1999 and 500,000 ha expected for 2000. The contribution to employment during 1999 is estimated at 2,892 person years and to the gross domestic product (GDP), US $23.7 million. Provided the 2000 goal of 500,000 ha is realized, the contribution to employment is expected to be 13,335 person years and an addition of US $286.5 million to the GDP.

As a further refinement, the ATDP project worked with local entrepreneurs to develop megagranules, which allowed farmers to place one granule at a time rather than three and saved about 20%-25% labor cost. Additionally, five megagranule (2.7-g particle) machines with a production capacity of 1 ton per hour have been purchased. The project is also working with several private companies to develop a USG applicator, which may virtually eliminate the drudgery of deep placement. If this achievement is realized, this project will go a long way toward ensuring the accomplishment of its goals in the year 2000 and beyond.

During 1999 IFAD provided funding for IFDC to evaluate and promote adoption of efficient, environmentally friendly plant nutrient management practices for paddy production in Bangladesh, Nepal, and Vietnam. The Adapting Nutrient Management Technologies Project is coordinated from Dhaka and is including urea deep placement as one of the practices. IFDC is coordinating NGOs' work directly with farmers and is focusing on expanding urea deep placement to new areas in Bangladesh and introducing the practice in Nepal. Negotiations are underway for Vietnam. The project is heavily involved in establishing baseline data for about 1,000 farm households to permit documentation of the adoption process.

Farmers like Belayet Hossain plan to increase the amount of their land under USG management in the coming season. "We cannot afford not to do so," he says. "All my rice crop will receive USG next year so that I can have more and healthier plants and more income for my family."

Dr. Ray B. Diamond (left, rear), Resident Coordinator, ANMAT-IFDC Project; Dr. B. N. Vyas, General Manager (Research & Development), Godrej Agrovet, Mumbai, India; Dr. Shantanu Mathur, Grants Coordinator/Technical Advisor, IFAD, Rome; Mr. Md. Ibrahim Khalil, Deputy Director, Department of Agricultural Extension, Tangail District; Dr. Amit Roy (right, foreground), IFDC President and Chief Executive Officer; and others visit a USG manufacturer in Tangail.

Planting Seeds of Hope in Kosovo

Kosovars Take Steps Toward Market Agriculture

In the charred earth of Kosovo, IFDC is planting seeds of hope for a brighter tomorrow for that province's people. IFDC has been working with NGOs and other entities since mid-October 1999 to reconstruct the agribusiness sector and convert a state-run agricultural system into a competitive market system.

The Coordinator of IFDC's Agribusiness Program, Ian Gregory, gained a very favorable impression of the Kosovar people at the beginning of the Center's project in that province. "When I arrived in Kosovo in October 1999, I was struck by the atmosphere of extreme activity," Gregory says. "In fact, it was almost surreal; everybody was busy working and repairing their houses, making them ready for winter. The donor community was very active in supplying reconstruction materials, humanitarian aid, etc. Then the reality checks set in—the burned-out villages, the utter destruction of the infrastructure, particularly the homes in the rural areas."

Operating throughout the Kosovar province from an office in Pristina, Richard Hicks is serving as the project's Chief of Party. Hiqmet Demiri, an Albanian citizen, is responsible for technical and agronomic matters and trade associations. Short-term, expatriate consultants are employed to assist with association development, grain marketing, and policy reform.

"There was a huge response by the global NGOs who were organizing relief aid, humanitarian aid, and some agricultural inputs for the Kosovo agricultural sector," Gregory says. "As a result of these efforts there were approximately 77,000 ha of wheat planted in September 1999. One must remember that this was after the return of the refugees from the surrounding countries only in the middle of June 1999. This was a remarkable effort all around, both by the Kosovar farmers and by the NGO relief organizations. Unfortunately the kind of humanitarian aid programs that supply seed and fertilizer for free to farmers disrupt the commercial market for the private sector. Unlike in Albania, in Kosovo there was an extensive network of agricultural input suppliers, which have

"An urgent task for the international community is to help developing countries become better integrated in the world economy, providing assistance to help them build up needed supporting institutions and policies, as well as continuing to enhance their access to world markets."

—From the Martin Forman Memorial Lecture, June 13, 2000 (Presented by Dr. Per Pinstrup-Andersen, Director General, International Food Policy Research Institute)

developed over the past decade as the Serbian authorities eliminated the ethnic-Albanian Kosovars from the official channels of trade."

"Prior to the conflict, agriculture accounted for about 35% of the gross domestic product of Kosovo," Gregory says. "At the end of 2000, that figure will probably be as high as 50%. Each farm family averages about 10 people; there are about 120,000 farms."

The main crops grown by Kosovar farmers are wheat and maize, with approximately 100,000 ha of wheat and 100,000 ha of maize being planted annually. In addition, there are another 100,000 ha of minor crops (forage for livestock); another 26,000 ha are planted in fruits and vegetables.

To help the Kosovar farmers prepare for this spring's planting season (2000), IFDC identified the demand for inputs—fertilizers, seeds, and crop protection chemicals—and then determined how much the donor organizations would be providing for free to selected Kosovar farmers. The results of IFDC's studies revealed that about US $40 million worth of agricultural inputs were required and of this, about US $10 millon or 25% would be provided by the donor organizations to approximately 70,000 of the most deserving farm households in Kosovo. The private sector had the capacity to supply another US $20 million worth of inputs on a commercial basis. However, this left a gap of US $10 million — a serious constraint on the amount of planting in the spring.

In spite of these constraints, IFDC has accomplished much in a very short time. "We have established three trade associations thus far," Gregory says. "These include the Kosovo Dealers and Agri-Inputs Association (KODAA); the Kosovo Flour Millers Association, and the Kosovo Poultry and Feed Association. KODAA now has approximately 150 members—retailers and major importers of agri-inputs. The Flour Millers Association consists of 80 mills, 74 in the private sector and 6 in the public sector. The Poultry and Feed Mills Association has recently been registered. In addition to these trade associations, several producer associations are being established by other organizations in Kosovo; one of the most important ones to date has been the vegetable producers' association.

The primary advantage of trade associations is that members can share information and be better informed on product technology and markets. This benefits their farmer customers."

IFDC is making progress in assisting Kosovo in the development of markets for farmers to sell their products. "IFDC has already surveyed private-sector flour mills and feed mills," Gregory says. "There are about 74 private-sector flour mills that have the capacity to supply all of the flour required by Kosovo. In addition, there are 6 public sector flour mills that have a capacity similar to that of the private sector. All of these flour mills, both public and private, are suffering from three primary constraints: lack of wheat, frequent interruptions of electricity to power the mills, and lack of credit to buy the raw material. IFDC is working with the flour mills to form a trade association and also on a proposal to import wheat rather than flour to allow these private-sector mills to become fully operational. The United Nations Mission in Kosovo (UNMIK) is working to restore the electricity supplies."

Besides the flour mills there are some milk processing plants and one fruit and vegetable processing plant that is not in operation. IFDC is studying the requirements for starting up that plant because we expect an overabundance of fruits and vegetables this summer.

"One of the main drawbacks in Kosovo was the absence of a banking system during the past decade," Gregory says. "UNMIK proclaimed new banking laws in December 1999. The European Union and other donors have established a micro-enterprise bank that has a small agricultural portfolio. Currently there are only three branches of this bank open. The Catholic Organization for Relief and Development Aid (CORDAID)—the largest Dutch NGO—is in the process of establishing a rural bank, based on agribusiness trade associations, to provide full banking services. IFDC is planning to assist CORDAID in providing technical assistance to its customers who are members of agribusiness trade associations. During the next year we expect to see several more banking and financial institutions established."

As for IFDC's future work in Kosovo, it will focus on policy development that is conducive to private-sector development, the further development of trade associations, and new trade contacts for these associations for both agricultural input and output markets. The Center also looks forward to the development of linkages between the Agriculture Department at the University of Pristina and the private-sector input dealers to provide private-sector extension services for farmers. IFDC recognizes that one of the crucial links in the development chain is the training of Kosovar agribusiness entrepreneurs in financial and business planning, marketing, and other activities as their businesses develop.

Reversing the Downward Nutrient Spiral

Integrated Soil Fertility Management Provides Option for Farmers of Sub-Saharan Africa

Togo is one of the world's poorest countries. Its average per capita income is less than one U.S. dollar a day. Marbau and Kissem and their five children farm three hectares of land, passed down from their ancestors, near the village of Afem Kabye, in central Togo. For centuries their ancestors cleared a few hectares of land, grew a few crops, and then later moved on to clear more land. They then left the land fallow for several years so that the soil could regain its fertility. Slash-and-burn farming was fairly sustainable when land was plentiful and people were few. But population across Africa is increasing about 3% per year. The soil can no longer rest; it must feed too many people. It is farmed continuously year after year. Each crop produces less than before, while removing the soil nutrients—food for the plants—that are left. It is a vicious cycle of poverty—soil poverty that leads to human poverty, which forces Marbau and Kissem to "mine" the soil of its life-giving nutrients, yet giving nothing back.

Researchers at IFDC and other IARCs have developed technologies that enable small-holder farmers like Marbau and Kissem under marginal conditions to use mineral fertilizer and to improve production levels and revenues while reversing nutrient depletion. This technology is based on the combined use of local resources and inorganic fertilizer and leads in time to more favorable cost: benefit ratios for mineral fertilizer use because of an improved nutrient and water-holding capacity of the soil.

"Integrated soil fertility management can reverse the downward spiral of soil fertility," says Dr. Henk Breman, Director of IFDC-Africa. "Through improvement in soil quality, the efficiencies of plant nutrients, water, and labor can be significantly increased. The combined use of mineral fertilizer and the locally available sources of organic matter improves the amount and the quality of soil organic matter or humus that is crucial for higher nutrient and water storage in the soil and for the efficiency of their use. Results from long-term experiments in the coastal savanna of Togo show the synergistic effects of organic/manure and mineral fertilizers. This

combined use also improves phosphorus availability and corrects soil acidity over time. Good agricultural practices, erosion control, improved crop and livestock varieties, diversification, etc., may be required as complementary measures."

Mineral fertilizers play a dual role in integrated soil fertility management; they stimulate plant growth and improve soil quality. Technically and economically, the best way to achieve this goal is by combining elements of ecological agriculture with fertilizer use. Five options are possible. First, with an increase in the use of fertilizers, better and higher amounts of crop byproducts become available for recycling that leads to a better quality and quantity of organic matter. Second, the rotation of cereals with leguminous crops like beans, cowpeas, and groundnuts, fertilized with phosphate fertilizers, improves soil organic matter, which in turn makes the application of other fertilizers on cereals profitable. Third, the fields are enriched with organic matter from elsewhere in the form of compost or animal manure. Fourth, the amount and the quality of manure can be increased by improving the quality and quantity of fodder for livestock; in a crop-livestock system, pastures of perennial grasses can be used in rotation with crops. Fifth, shrubs or trees are introduced in crop production systems to obtain more plant biomass for recycling and, thus, improve fertilizer use on crops.

"It cannot be stressed enough that, in all of these cases, organic matter is not used as an alternative to fertilizer but as a soil amendment that leads to a higher response to fertilizer use," comments Dr. Amit H. Roy, IFDC's President and Chief Executive Officer. "This management practice is 'better' in view of the higher efficiency and more favorable cost:benefit ratios and in view of decreased losses of nutrients to the environment."

According to Breman, mineral fertilizer use is absolutely essential in reversing the negative trend of soil nutrient depletion in sub-Saharan Africa (SSA) and arresting the degradation of natural resources and the social fabric that is causing desertification and rural-urban migration. However, except for a few favorable regions and high-valued crops, the cost:benefit ratio of fertilizer use does not provide an incentive to farmers. Integrated soil fertility management makes the cost : benefit ratio more attractive through higher fertilizer-use efficiency and lower environmental risk. During the initial period of adoption of integrated soil fertility management technologies, the support of governments and/or donors is vital because of the predominance of small holder farmers and marginal lands in SSA.

"And the soil said to man: Take good care of me or else, when I get hold of you, I will never let your soul go."

—Kipsigis proverb, as told by Arap Keoch, Chemorir, Kenya, 1990

From Drawing Board to Farmers' Fields

Strategic Framework for Africa's Agricultural Input Supply System: Blueprint to Food Security

"Land never disappoints. Invest in it and you will have your returns."

—From the Ewe people

Dr. Norman E. Borlaug—the 1970 Nobel Peace Prize recipient, President of Sasakawa Africa Association, and an IFDC Board member—realizes the importance of input and output marketing systems to agricultural and economic development. In a speech in Jakarta in 1997, he said, "If there is political stability and if effective input supply and output marketing systems are developed, including a viable agricultural credit system, the nations of SSA can make great strides in improving their nutritional and economic well being."

As Dr. Borlaug clearly understands, the nations of SSA face a host of inter-linked problems in attempting to increase agricultural production so that they can achieve food security and stimulate rural development, which is key to their progress. Agricultural input marketing represents a critical component of the intensified and sustainable agricultural system necessary for the long-term welfare of farmers and their land. Availability and adoption of modern inputs can at least triple current yields of

cereals for most SSA farmers, who currently, for example, use less than 10 kg of plant nutrients per hectare, compared with a world average of 90 kg/ha.

African governments have been restructuring their economies to reduce the role of the public sector in agribusiness, thus opening opportunities for free markets and private enterprise. However, domestic and foreign private entities have often not filled the vacuum created by the withdrawal of governments from supplying agricultural inputs. The reasons for the lack of response include such factors as small markets, poor access to credit, high transport and other costs that restrict sales, and distortions from donor supplies. With cessation of subsidies and of parastatal suppliers, use of modern agricultural inputs has stagnated in most of Africa at the level of small holder farmers of staple foods.

The donor community and the countries themselves recognized the need to correct the situation by increasing the supply of affordable inputs. In 1999 the Africa Bureau of USAID asked IFDC to design a strategic framework that could help governments, donors, and NGOs undertake actions to improve the accessibility of fertilizer, high-yielding variety seeds and crop protection chemicals. Both parties recognize that the use of modern inputs is directly related to demand that is generated by markets for the produce.

A partner with USAID since its beginning 25 years ago, IFDC has undertaken numerous activities throughout Africa that contribute to understanding the complex arena of agricultural inputs and the means to improve efficiency of marketing and use. Drawing on its extensive experience, presence, and networks in the region, IFDC proposed a plan of action that would involve a dozen collaborating institutions and scores of stakeholders and practitioners in the field.

The objective was to characterize the various stages of input development and to prescribe realistic, tailored remedial steps that the key actors can take. The aim is to promote open, competitive and reliable distribution networks that will serve small farmers and help encourage intensive and environmentally sound agriculture. During 1999 IFDC undertook a review of over 300 literature sources, prepared new country case studies, and sent out 400 questionnaires primarily to involved Africans. The Center then shared drafts of the framework with collaborators from a cross-section of state-of-the-art knowledge, including the main trade associations that represent the three key agricultural input industries. In July 1999 IFDC convened an international workshop with the United Nations ECA in Ethiopia to validate the findings and the draft framework.

The Strategic Framework document, completed at the end of 1999, is geared for action. Government, donors, private sector and NGOs can easily assess the inputs' stages and the actions that each should take under various scenarios to advance the country. The stages range from subsistence to emergence to growth to maturity. The underlying theme is that the agricultural input supply and marketing should be open, competitive and in the hands of the private sector. The framework advocates a holistic approach with attention not only to input

> **"(We have) not only the opportunity but also the awesome responsibility to leave our children—and their children—a healthier soil and a better future."**
>
> **—Dr. Amit H. Roy, IFDC President and Chief Executive Officer**

supply systems but also to product markets, private sector-led marketing and government support in creating an environment that is conducive to increased agricultural productivity and well being of farmers. The Framework offers prescriptions on such topics as:

- Policies and regulatory systems that define opportunities and provide incentives
- Institutional capacities, including infrastructure, information flows, and extension
- Linkages with the output markets and agricultural processing
- Removal of subsidies and privatization of parastatal organizations
- Development of trade associations and regional markets, including harmonization
- Training for input dealers in business, access to credit, technology and service to clients
- Promoting competition and freedom of entry
- Guidelines for effective input markets

Some of the conclusions of the related studies include:

- Agricultural systems will be sustainable only when sufficient incentives exist that increase profits, reduce risks and encourage non-farm, and revenue-generating activities. Input marketing is a sub-component of the total agribusiness system. Effective demand by end user markets of food products is the engine that drives the system.
- Economic liberalization has often failed to produce competitive markets and responsive agricultural entrepreneurs. The level of development of input markets remains low. The reasons include relative high cost of products, low and risky profitability for most farmers, weak financial markets, second-generation policy constraints, and inadequate soil management techniques for nutrient-depleted fragile soils, all of which render returns on inputs too low.

There are no simple solutions and few examples of sustainable success in improving agricultural input markets in the countries of SSA. However, with the right policies and strategically targeted, simultaneous support, it is possible to develop an open market system anchored in the domestic private sector that will serve farmers, contribute to food security, and help protect the environment.

The framework prescribes, among other things, the development of trade associations and of regional markets to benefit from economies of scale in supply. This would reduce costs of agricultural inputs to farmers and help them raise productivity. "For example, each of the eight West Africa countries, forming the West African Economic and Monetary Union (UEMOA), import about 10,000 tons of fertilizer per year and sell to farmers at US $400/ton compared to the CIF cost of about US $220 on average," says Dr. S. K. Debrah, IFDC-Africa Policy Economist. "An association of importers within the UEMOA region can import a regional consignment of approximately 100,000 tons and sell to farmers at between US $250 and US $300/ton."

IFDC is confident that the Framework can help transform agricultural input marketing systems in SSA, based in part on its successful experiences in Albania and Bangladesh. In 1992 Albania represented ground zero in terms of private-sector development, including a collapse of the agricultural input marketing system. With business and technical guidance, the nascent entrepreneurs identified by IFDC were able to establish a reliable, efficient distribution network that serves farmers well. That strategy can work in Africa too.

Overdrawn African Soils Bank Account

IFDC-Africa Coordinates Consortium to Combat Nutrient Depletion in West African Savannas

"What happens if you continuously remove nutrients from the soil?" asks Dr. Amit H. Roy, IFDC President and Chief Executive Officer. "It is like continuously taking money out of your checking account without replacing it. Ultimately, you'll have no money. The same thing is happening to the soils of sub-Saharan Africa, where the farmers are continuously mining the soil without replenishing it with external inputs (nutrients)."

To provide answers to this dilemma, IFDC, IITA, Ahmadu Bello University in Zaria (Nigeria), and INRAB (Benin) have been collaborating on CNDC in the West African savannas since 1997. This research work is conducted as part of the Soil, Water, and Nutrient Management program of the CGIAR. The focus of CNDC activities in West Africa is not so much to initiate new research as to achieve greater impact from present knowledge. The primary focus is therefore to develop and use tools such as simulation models and decision support systems that synthesize available information on soil, water, and nutrient management and make it accessible to a range of clients. The research considers agroecological and socioeconomic factors and is conducted in benchmark sites of the EPHTA.

Across most of SSA, food production is not keeping pace with population growth. Experts estimate that even if annual population growth stabilizes at 2.5%, the demand for food in SSA in the year 2025 will triple 1990's demand. Agriculture in the SSA is confronted with numerous constraints. Two of the most significant problems are low crop yields and limited adoption of improved technologies that have been produced by scientists. Equally troubling is the degradation of the natural environment because of expanding cultivated areas, shorter fallow periods that prevent the soil from regenerating its fertility, increased pressures on fragile land, and extension of farming into unsuitable marginal lands. Creating further complications

In spite of the adverse weather conditions that severely limit yields, Augustin Atiye remains confident that his crop production will improve. He is determined to succeed.

are inadequate marketing systems, inappropriate national agricultural policies, and inadequate numbers of trained human resources.

"The CNDC was formed to work with African farmers to combat nutrient depletion based on the principle that the restoration and maintenance of the soils of SSA is fundamental to sustainable development in the region," says Dr. Upendra Singh, IFDC Senior Systems Modeling Scientist.

The plan of action was derived from three working hypotheses:

1. More rapid, more economic and more sustainable increases in productivity can be achieved by investment in nutrient recapitalization than by recurrent fertilization.
2. Management of soil by integrated use of organic and inorganic sources of nutrients will lead to greater productivity, increased efficiency of nutrient use and cycling, and reduction of negative on- and off-site impacts on the environment and natural resource base.
3. Effective implementation of measures to improve soil fertility is dependent on appropriate institutional frameworks and policies compatible with community and household goals and objectives.

"The comparative advantage of the consortium is its ability to bring together a critical mass of expertise that can develop strategies to rebuild and maintain soil fertility on depleted lands including improved nutrient acquisition and management strategies and innovative policy initiatives," Singh says. "The key issues facing the CNDC are plant nutrient mining, associated soil degradation, and low farmer-adoption of nutrient management strategies. The success of CNDC is dependent on achieving an agroecological sustainability in nutrient balance. The improvement and maintenance of nutrient balance would involve amendments for improvement of soil organic matter status, phosphorus availability, and soil pH and use of inorganic and organic fertilizers."

In essence, the nutrient management technologies developed must consider agroecological and socioeconomic sustainability for successful farmer adoption. The traditional manner of technology evaluation by field trials over many seasons and sites is not only costly and time consuming, but it samples only a fraction of management options available to the farmer.

The Consortium has participated in the on-going capacity building of NARS scientists in the use of decision support tools (databases for soils and climate, crop simulation models, and geographic information systems) to help identify appropriate nutrient management strategies for diverse agroecological and socioeconomic conditions in the SSA. The CNDC has developed, refined, and applied DSS to improve information and technology dissemination to and by researchers, extensionists, and farmers. As further application of CNDC decision support tools, IFDC in collaboration with ICRISAT has undertaken a West African transect study to quantify nutrient and water limitations for the key crops in the region.

"During the past 50 years, over 1 billion hectares of arable land has been degraded due to inappropriate agricultural practices. A large portion of this damage was caused by soil degradation and deforestation resulting from inadequate replenishment of nutrients. Unless the removed nutrients are replenished adequately, soils cannot be sustained for posterity, and the removed nutrients cannot be adequately replenished unless mineral fertilizers are used. It is no exaggeration to say that there is no 'sustainable food security' without mineral fertilizers. There may be risks in using fertilizer, but the risks of not using them are even higher. If the nutrient status of the soil is not addressed, an environmental disaster will be inevitable. "

—Dr. Henk Breman,
Director, IFDC-Africa

Research Results—Like Money in the Bank

Brazilian Scientist's Research Translates Into Lower Costs of Fertilizers for Farmers

In an IFDC greenhouse, Dr. Luis Prochnow, Visiting Scientist from Brazil, investigates the use of his country's phosphate rock to increase food production.

In Brazil some local phosphate rocks that have a high content of iron and aluminum impurities are used in the production of acidulated phosphate fertilizers. Fertilizer manufacturers have used expensive industrial processes to reduce the concentration of impurities so that the acidulated phosphate products can meet the current Brazilian law, which specifies a minimum content of total available and water-soluble phosphorus in commercial phosphate fertilizers. For example, for single superphosphate, the minimum total available phosphorus content is 18%, of which 16% must be water-soluble phosphorus.

Since the agronomic effectiveness of phosphate fertilizers is influenced by soil properties and crop species, it is possible that the requirement of water-soluble phosphorus content could be lower for certain crops and soils. If so, the Brazilian fertilizer industry and farmers could realize a significant saving. With this in mind, Dr. Luis I. Prochnow, Assistant Professor, Department of Soil and Plant Nutrition, University of Sao Paulo, came to IFDC to conduct a 2-year research program with IFDC scientists—

Dr. S. H. Chien and Mr. S. J. Van Kauwenbergh—and also in collaboration with Dr. R.W.Taylor of Alabama A & M University.

Dr. Prochnow's work includes the identification of minerals in various Brazilian phosphate fertilizers by x-ray diffraction and scanning electron microscopy that will be related to the solubility and agronomic effectiveness of phosphate fertilizers. "In a recently completed greenhouse experiment with upland and flooded rice grown on an acid soil, we found that a single superphosphate with only 46% of total available phosphorus content as water-soluble phosphorus was 88% as effective as 100% water-soluble phosphorus in increasing dry-matter yield of upland rice," Prochnow says. "For flooded rice, there was no difference for the two phosphorus sources in increasing dry-matter yield. The results suggest that the acidulated phosphate fertilizers with a content of water-soluble phosphorus as low as 46% of total available phosphorus could be agronomically as effective as phosphate fertilizers with high water-soluble phosphorus content for rice production. The results also suggest that acidulated phosphate fertilizers that have a lower water-soluble phosphorus content and contain iron and aluminum impurities may be more agronomically effective for flooded rice than for upland crops because of the soil reduced conditions after flooding, which promote dissolution of iron and aluminum phosphates."

Dr. Prochnow has conducted more experiments to study the effect of water-soluble phosphorus content on the agronomic effectiveness of phosphate fertilizers. One experiment examined the previously described effect of the phosphorus sources applied to upland and flooded rice on the residual effectiveness for wheat. Another experiment focuses on mixing water-leached phosphate fertilizers with a water-soluble phosphorus compound at different ratios to study the minimum requirement of the water-soluble phosphorus content in acidulated phosphate fertilizers for wheat grown on acid soils. The third study involved the agronomic evaluation of modified phosphates produced from a low-reactivity Brazilian phosphate rock (Patos de Minas), which is not suitable for direct application. The modification includes partial acidulation of phosphate rock with sulfuric acid and compaction of phosphate rock with single superphosphate at 50:50 P_2O_5 ratio. The test crops are wheat and ryegrass.

"When Dr. Prochnow completes his study at IFDC, he will have some valuable scientific information that is very important to the fertilizer industry and farmers in terms of the use of appropriate cost-effective phosphate fertilizers for crop production in Brazil," says Chien. "It is hoped that this research will translate into a saving for Brazil's fertilizer industry and its farmers."

Nurturing Malawi's Budding Agribusinesses

Entrepreneur From Malawi Continues to Benefit From IFDC Training

David Kamchacha fully understands the importance of training. After attending an IFDC marketing training program during 1994 as a senior employee of Farmwise, Inc.—one of the first private-sector inputs marketing companies in Malawi—he was offered a position with another company, which meant a promotion for him. In 1998 he established his own company, and in September 1999 under the sponsorship of USAID, Kamchacha returned to IFDC to gain further insights and ideas for the development and operation of his company.

"When I attended the marketing program in 1994, I was serving as Senior Operations Manager for Farmwise, Inc., where I was responsible for market development, planning, and training of field staff," Kamchacha says. "The agricultural inputs market had just been liberalized in Malawi. The skills that I received at IFDC helped me to develop a marketing plan that had an impact on the distribution of fertilizer from the private-sector perspective. Because of the success of that plan, more companies were interested in hiring me."

In 1996 Kamchacha moved to another company, Farmers' World, where he produced a 5-year marketing plan for that company; at the time the company had only 8 shopping outlets—but after his plan was implemented the sales outlets numbered 40.

"During that period—even after market liberalization—there were only three fertilizer companies operating," Kamchacha says. "I saw that the farmer was not really benefiting because of the lack of competition. In August 1998 I started Produce Mart International, Ltd., (PMIL) to add to the competition. Our company concentrates on supporting small-holder farmers by providing essential farm inputs from a site near them. One of our objectives is to be a model distributor of high-quality farm inputs and general merchandise. Our main line of business is fertilizer, but we supplement this with agrichemicals and seeds. When we formed the company, we had only 4 sales outlets and 25 employees. Now we are opening 10 more outlets and enlarging to 40+ employees. During 1999 we have sold 9,000 tons of fertilizer, compared with 4,500 tons in 1998."

Kamchacha realizes that he has the advantage of being a pioneer in the liberalized fertilizer market. "Because of this I have had the opportunity of establishing a favorable relationship with farmers—they always follow me," he says. "My training at IFDC enhanced my skills in marketing, computer science, and accounting and helped me to develop my company much faster and more successfully."

David Kamchacha (left) listens while a horticulturalist explains a point to a Malawi farmer who would like to develop his farm for commercial production.

"The first time I attended the program I was an accountant; now I am a company president and have a different perspective," Kamchacha says. "I have a much broader background now and have a wider range of interests. In addition, I am making new contacts with overseas suppliers that will be beneficial to my company's future. Much of the credit for my success belongs to IFDC. Its publications and training have been very helpful to me."

When Kamchacha returned to his homeland after attending the IFDC training program in 1999, he began training his field staff based on the skills that he had acquired during the program. "One of the IFDC publications that helped me *was Developing the Fertilizer Dealer: Emphasizing the Small Farm Sector,"* Kamchacha says. "We are training our field staff to know how the farmers can best utilize the products and the potential problems in their use. Our field visits to different cooperatives and fertilizer dealers during the training program at IFDC encouraged me to work hard and develop my supply system in Malawi."

Kamchacha thinks the Malawi agriculture sector needs to be diversified and that trained people in the private sector can make an impact. At the same time, he recognizes the challenges confronting the agriculture sector in Malawi. First, there are problems in obtaining foreign exchange for imports. Interest rates are high. Rural roads are almost impassable during the rainy season. Fertilizers imported into Malawi are usually in small parcels; thus, the prices are high. There is inadequate linkage with international markets and very limited information on global trade.

Developing market information systems has always been a priority with the Malawi entrepreneur. Because of this he is always kept up-to-date regarding the fertilizer market, and having this information helps him to make the right decision at the right time. "The current fertilizer market in Malawi is about 191,000 mt, and on the basis of consumption estimates for 1999 and 1.7 million ha of cropped arable land, the nutrient use per hectare is 43 kg," Kamchacha says. "There is, therefore, a good potential for the use of fertilizer to increase greatly from present levels. During the current cropping season Malawi will harvest 2.4 million tons of maize; last year's harvest was about 2.1 million tons. Thus, this situation will cause the price of maize to decrease."

At present Malawi's output market is not developed, and as a result, farmers do not have the incentive to produce. PMIL, Kamchacha's company, is developing strategies whereby it can provide output markets for its customers and thereby ensure a complete agricultural marketing system, as encouraged by IFDC. The company plans to purchase produce from farmers to establish an export market and build silos for grain storage for commercial purchases.

"Because of my training at IFDC I understand the important role that customer service plays in the success of a business," Kamchacha says. "Extension services create an opportunity for me to establish a lasting relationship with my farmer customers. When I visit the farmers in their fields, I can see what they are doing and evaluate the performance of the products that I sold to them. Recently, I have been educating the farmers on the economic use of fertilizers and the benefits of using high-analysis rather than low-analysis fertilizers."

As a result of his training and experience, Kamchacha is planning to enhance his business even further. "I am currently working to strengthen my position in the market and seeking financial assistance to provide working capital for my business," he says. "Given the availability of financial resources, I hope to access the international fertilizer markets where prices are low compared with the traditional South African market. We would like to advance into fertilizer blending in the future. In the past few months, we have joined with an associate company, STC Group, for the purpose of increasing our market share, sourcing imports, and promoting a fertilizer dealers' network and association for Malawi."

In spite of the constraints to Malawi's agriculture sector, that country's future should be brighter when one considers the expertise and determination of entrepreneurs like Kamchacha and the contributions that they can make to the future of their country.

Getting Your Daily Vitamins and Minerals

The Role of Micronutrient Research in Human Nutrition

"Inadequate intakes of micronutrients continue to be major problems affecting more than one-third of the world's people, and these nutritional deficiencies impair growth, physical and intellectual development, activity and survival predominantly among women, infants, and children in developing countries. Micronutrient intakes have not kept pace with improvements in staple food production that have been realized over the past 25 years in many parts of the world. Micronutrient content has not been a goal of agricultural systems in any part of the world."

This was a declaration made at the conclusion of a workshop on "Food-Based Approaches to Preventing Micronutrient Malnutrition," which was held in Salt Lake City, Utah, in 1995 and attracted more than 100 participants from 29 countries.

In developing countries the problem of micronutrient deficiencies is tremendous. Available estimates are cause for alarm. It is estimated that more than half of pregnant women and school age children suffer from iron deficiency anemia, as do more than 40% of nonpregnant women and preschool children. Only recently has attention been focused on zinc deficiency, which has symptoms that are just as serious as those of iron deficiency.

IFDC's Dr. S. H. Chien, Senior Soil Chemist, believes that agricultural researchers can provide answers to this problem. "Cost-effective food-based systems could offer sustainable solutions to micronutrient malnutrition associated with the lack of some micronutrients such as iron and zinc in the human diet in many countries," Chien says. "Since plant foods contribute as much as 90% of the total dietary consumption in developing countries, enrichment of iron and zinc in staple food represents an attractive means of addressing the need for increased iron and zinc uptake, particularly for infants, children and women of childbearing age. Innovative research is needed to generate new knowledge for the use of food-based approaches to prevent micronutrient malnutrition by increasing the micronutrient content of food crops."

In general there are two strategies toward the solution. One is to breed genotypes that are more efficient in absorbing iron and zinc from soils

and also to increase translocation of these elements from roots, leaves, and stems, to seeds or grains that are consumed by humans. The other approach is to develop genotypes that will produce grains low in phytic acid, which is known as an anti-micronutrient compound due to its precipitation of iron and zinc in the human intestine. Such genotypes with low phytic acid thus can increase the bioavailability of iron and zinc to humans.

"To achieve the goal of sustaining or increasing crop yields with improved nutritional value, a successful plant breeding program will require an effective fertilizer strategy," Chien says. "As previously noted by Dr. Norman Borlaug, the Green Revolution would not have been possible without the synergistic effect of plant breeding and fertilizer inputs. Therefore, it seems logical that a combination of an innovative plant breeding and fertilizer management program can offer an effective strategy to solve the problem of micronutrient malnutrition. For example, a recent study conducted by IFDC using a new type of iron-rich phosphate fertilizer for barley genotypes with low phytic acid showed that iron concentration in barley grain was increased by 32%-38%, whereas phytic acid was decreased by 40%-50%."

With sufficient funding support, IFDC will embark on a systematic, comprehensive research program of fertilizer management to produce high yield with high micronutrient density of staple food crops in developing countries. This program will involve testing of new or modified types of micronutrient fertilizers in conjunction with crop cultivars that have been developed by plant breeders as efficient micronutrient absorbers or carrying traits with low phytic acid.

"No man is an island entire unto itself; everyone is . . . a part of the maine; . . . any man's death diminishes me, because I am involved in Mankind; And therefore never send to know for whom the bell tolls; it tolls for thee."—John Donne

Rock From the Earth Lowers Price of Canola Oil

A Cost-Effective Strategy Increases Yield of High-Value Canola Crop

Deficiencies in soil nutrient levels constitute a significant limiting factor for improved crop yields in developing countries. Efforts to promote the improved use of commercially available fertilizers have been somewhat successful. However, many developing countries in Africa, the Middle East, and Central and Southern Asia contain neutral and alkaline soils that have seriously constrained the development of a sustainable agriculture.

Dr. Leila Habib, former Visiting Scientist to IFDC, examines a canola experiment in the IFDC Greenhouse.

A significant problem is that these soils are usually low in phosphorus, an essential nutrient for crop production. The application of conventional, chemically acidulated phosphate fertilizers has not been widely practiced by resource-poor farmers, primarily because of the high cost of phosphate fertilizers that are either locally produced or imported. Many countries in these regions possess significant phosphate rock deposits, for example, Tunisia, Jordan, Egypt, Kazakhstan, Pakistan, India, Tanzania, and Ethiopia. However, existing research results indicate that the use of low-cost indigenous phosphate rocks for direct application is not feasible for crop production in these regions because of the low dissolution rate of phosphate rock caused by high soil pH.

"Breaking the Cycle of Poverty and Hunger"

Recent IFDC greenhouse studies have shown that the application of phosphate rock alone or a mixture of phosphate rock and water-soluble phosphate fertilizer can be agronomically effective for canola (rapeseed), which is a high-value oilseed crop, grown on neutral and alkaline soils. Although high pH does not favor phosphate rock dissolution in neutral and alkaline soils, the canola's root can exudate two organic acids (malic acid and citric acid) that can help dissolve phosphate rock in high pH soils. In these studies a four-fold increase of canola yield over the control (no phosphate added) was obtained with a phosphate rock from Kazakhstan in a neutral soil, and a seven-fold increase was obtained with a Syrian phosphate rock in an alkaline soil. A mixture of phosphate rock and chemically acidulated triple superphosphate, at 50:50 P_2O_5 ratio, was found to be as effective as triple superphosphate for canola grown on alkaline soils containing calcium carbonate (calcareous soils). These results have tremendous agronomic and economic implications for the use of phosphate fertilizers on canola and similar crops grown on neutral and alkaline soils if they are verified under field conditions, that is, through agronomic field trials in countries where the technology can be transferred to farmers.

"This research is tremendously beneficial to resource-poor farmers growing canola and similar crops on neutral and alkaline soils; their incomes will increase as a result of higher profits associated with the use of a low-cost input to grow a high-value crop," says Dr. S. H. Chien, IFDC Senior Soil Chemist. "The preliminary estimated economic value of canola can be as high as US $580 million. (This value was estimated by assuming only 5% of the arable land of five countries [Ethiopia, Tanzania, Egypt, Jordan, and Kazakhstan] is cultivated with canola at a low-to-medium yield of 0.5 t/ha; high yield is normally 1.5-2.0 t/ha). Furthermore, a saving of approximately US $3.4 million to the farmers may be realized by replacing only 5% of the total P_2O_5 consumption in these countries with indigenous phosphate rocks for canola production. The consumers of canola and similar products in the selected countries will also benefit from the project as a result of increased supply of crop outputs and lower prices. The countries will benefit from the improvement in their economies and the conservation of land resources—improvements in soil fertility and prevention of soil nutrient depletion leading to land degradation."

Financial Highlights

The following is a summary of financial information for the year ended December 31, 1999. The full financial statements and the independent auditors' reports are available from IFDC upon request.

Balance Sheet

For the year ended December 31, 1999

	US $'000
Assets:	
Cash and cash equivalents	1,933
Short-term investments	59
Contributions receivable	935
Contracts receivable, net of allowance for doubtful accounts	363
Other receivables	188
Supplies inventory	124
Prepaid expenses	53
Total current assets	3,655
Buildings and equipment, net	1,937
Contributions receivable, noncurrent	261
Total assets	5,853
Liability and Net Assets:	
Current portion of lease payable	20
Accounts payable	809
Accrued annual and sick leave	336
Deferred revenue	405
Total current liabilities	1,570
Lease payable, less current portion	21
Total liabilities	1,591
Unrestricted net assets	3,732
Temporariliy restricted	530
Total liabilities and net assets	5,853

Statement of Revenue and Expenses

For the year ended December 31, 1999

	US $'000
Revenue and Support:	
Agrium CPO	106
U.S. Department of the Treasury	568
Cargill, Inc.	135
CGIAR/Centro Internacional de Agricultura Tropical (CIAT)	74
Government of Bangladesh/Agribusiness Credit Fund	238
International Fertilizer Industry Association	203
International Fund for Agricultural Development	375
International Minerals and Chemical Corporation	118
Netherlands Minister for Development Cooperation (DGIS)	648
The Citizens Network for Foreign Affairs	117
The Fertilizer Institute	147
The World Bank	260
U.S. Agency for International Development	7,648
Western Mining	140
Training Programs	226
Others	643
Total revenues and support	11,646
Expenses:	
Field programs	1,741
Research	1,997
Outreach	6,106
Support activities	2,014
Total expenses	11,858
Decrease in unrestricted net assets	(212)

IFDC's Revenue Sources, 1999

Agricultural University of Wageningen
Agrium CPO
Bundesministerium für Wirtschaftliche Zusammenarbeit of the Federal Republic of Germany (BMZ)
Cargill, Inc.
CGIAR/CIAT
Christmas Island Phosphates
Ecoregional Fund
Engro Chemical Pakistan Ltd.
Food and Agriculture Organization of the United Nations (FAO)
FPM
France
Germany
Government of Bangladesh/Agribusiness Credit Fund
Government of Togo
Instituto Nacional de Investigacion Agropecuaria (INIA)
International Fertilizer Industry Association (IFA)
International Fund for Agricultural Development (IFAD)
International Minerals and Chemical Corporation (IMC)
Japan International Research Center for Agricultural Sciences (JIRCAS)
Netherlands Minister for Development Cooperation (DGIS)
Norwegian Agency for Development (NORAD)
Ocean Farming, Inc.
Rajasthan State Mining & Minerals Ltd. (RSMML)
Sasakawa Global 2000
Swiss Agency for Development and Cooperation (SDC)
Switzerland
The Citizens Network for Foreign Affairs (CNFA)
The Fertilizer Institute (TFI)
The World Bank
U.S. Agency for International Development (USAID)
U.S. Department of Treasury
University of Hohenheim
Western Mining

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1. Left during 1999.
2. Retired during 1999.
3. Deceased, 1999.

a. Seconded to IFDC by DGIS (Netherlands).
b. Virginia Polytechnic Institute and State University.
c. Seconded to IFDC by Agricultural University (Netherlands).

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IFDC's Publications, 1999

T-48 *Estimating Rates of Nutrient Depletion in Soils of Agricultural Lands of Africa*

T-49 *An Evaluation of Strategies to Use Indigenous and Imported Sources of Phosphorus to Improve Soil Fertility and Land Productivity in Mali.*

T-62 *Stratégie Nationale et Plan d'Action de Gestion Intégrée de la Fertilité des Sols* (National Strategy and Action Plan for Integrated Soil Fertility Management), Ministry of Burkina Faso/IFDC-Africa.

S-22 *IFDC Annual Report 1998.*

SP-26 *Privatization and Deregulation—Needed Policy Reforms for Agribusiness Development.*

SP-35 *Linking Soil Fertility Management to Agricultural Input and Output Market Development: The Key to Sustainable Agriculture in West Africa.*

LS-2 *Long-Range Perspectives on Inorganic Fertilizers in Global Agriculture.*

FSR-1 *Africa Fertilizer Situation.*

FSR-2 *Asia Fertilizer Situation.*

FSR-3 *Latin America Fertilizer Situation.*

FSR-5 *North America Fertilizer Capacity.*

FSR-6 *Eastern Europe Fertilizer Situation.*

FSR-7 *Worldwide Urea Capacity Listing by Plant.*

FSR-8 *Worldwide DAP and MAP Capacity Listing by Plant.*

FSR-9 *Worldwide Potash Capacity Listing by Plant.*

FSR-10 *Worldwide Ammonia Capacity Listing by Plant.*

FSR-11 *Worldwide Directory of Fertilizer Traders, Importers, and Organizations.*

FSR-12 *A Guide to Fertilizer Products for Traders.*

FSR-14 *Worldwide Ammonium Nitrate and Calcium Ammonium Nitrate Capacity Listing by Plant.*

FSR-15 *Recent Fertilizer Project Announcements: Worldwide.*

FSR-16 *Global and Regional Data on Fertilizer Production and Consumption, 1961/62-1998/99.*

FSR-17 *World Fertilizer Supply/Demand Situation.*

FSR-18 *Western Europe Fertilizer Situation.*

FSR-19 *Former Soviet Union (FSU) Fertilizer Situation.*

FSR-20 *North America Fertilizer Situation.*

FSR-21 *China Fertilizer Situation.*

FSR-22 *Worldwide NPK Capacity Listing by Plant.*

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