tribute to cgiar members

The 64 Members of the Consultative Group on International Agricultural Research (CGIAR) provide the human, technical, intellectual and financial resources that enable the Future Harvest Centers of the CGIAR to bring the benefits of modern science to poor people. It is the Members' core support and dedicated commitment to science that allows Center scientists to undertake the complex and often long-term research that has the most potential to deliver real benefits with global applications. Without this valuable support, food production would be lower, environmental damage would be more severe, and malnutrition would afflict many millions more children.

Each year, in tribute to the Members, the annual report highlights two CGIAR Members' engagement with the CGIAR. This year, we describe the extensive and effective joint work program with the CGIAR maintained by the International Fund for Agricultural Development and the enduring strategic support of Mexico.

The Center stories that follow also pay tribute to the Membership while recounting the power of science to bring about positive change. Each achievement is the result of Members' support. As these few examples provide only a glimpse of the innovative work underway at the CGIAR Centers, readers are encouraged to find more information by exploring the websites, annual reports and other publications of individual CGIAR Centers.

Amplifying these research achievements is the strength of our partnerships, which embrace the public and private sectors, civil society organizations, farmers, and the scientific communities of industrialized and developing countries.

African Development Bank

Arab Fund for Economic and Social Development

Asian Development Bank

Australia

Austria

Bangladesh

Belgium

Brazil

Canada

China

Colombia

Commission of the European Community

Côte d'Ivoire

Denmark

Arab Republic of Egypt

Finland

Food and Agriculture Organization of the United Nations

Ford Foundation

France

Germany

Gulf Cooperation Council of the Arab States

India

Indonesia

Inter-American Development Bank

International Development Research Centre

International Fund for Agricultural Development

Islamic Republic of Iran

Ireland

Israel

Italy

Japan

Kellogg Foundation

Kenya

Republic of Korea

Luxembourg

Malaysia

Mexico

Morocco

Netherlands

New Zealand

Nigeria

Norway

OPEC Fund for International Development

Pakistan

Peru

Philippines

Portugal

Rockefeller Foundation

Romania

Russian Federation

South Africa

Spain

Sweden

Switzerland

Syngenta Foundation for Sustainable Agriculture

Syrian Arab Republic

Thailand

Turkey

Uganda

United Kingdom

United Nations Development Programme

United Nations Environment Programme

United States of America

World Bank

IFAD and the CGIAR: An Effective Partnership

Since its inception in 1977 as a specialized agency of the United Nations, the International Fund for Agricultural Development (IFAD) has supported agricultural research that generates pro-poor technologies with impact. Its loan and grant programs have improved the livelihoods of the rural poor by building on readily adoptable opportunities for income diversification based on increased productivity, value addition, market access and other complementary strategies. IFAD has pioneered approaches that now find wide relevance in national poverty-reduction strategies and international plans that harness science and technology to achieve the Millennium Development Goals.

IFAD's current Strategic Framework identifies equitable access to productive natural resources and technology as a strategic objective for enabling the rural poor to overcome poverty. The Fund's grant policy aims 1) to promote pro-poor research on innovative approaches and technological options to enhance field-level impact and 2) to build the pro-poor capacities of partner institutions including community-based organizations and nongovernmental organizations. These objectives have contributed to the enrichment of appropriate pro-poor technology options as well as supported reform of pro-poor research governance.

Regarding agricultural research and development led by the Consultative Group on International Agricultural Research (CGIAR), IFAD's investments have supported the generation and diffusion of sustainable agricultural technologies through participatory approaches in resource-poor and disadvantaged environments. In its first 26 years, IFAD committed US$130 million to 94 CGIAR-led research initiatives. Strong evidence exists that these investments are among the most cost-effective contributors to reducing rural poverty. They have had widespread impact on small-scale agriculture throughout the developing world and have helped focus the System's attention on priority issues of concern to the rural poor and on traditional crops and commodities grown in difficult environments. IFAD has supplemented its grant support with a strong advocacy role in CGIAR forums to address issues within IFAD's mandate.

Investments have supported the generation and diffusion of sustainable agricultural technologies through participatory approaches in resource-poor and disadvantaged environments

IFAD is active in the CGIAR Executive Council as a Cosponsor and has contributed to the dialogue on CGIAR reform and its programmatic and organizational alignment for enhanced effectiveness and efficiency. Indeed, all of the CGIAR-led research supported by IFAD — focused as it is on developing sustainable agricultural technologies to address rural poverty — directly facilitates the CGIAR reform agenda. A promising analytical perspective is offered by the Institutional Learning and Change Initiative that IFAD supports with like-minded CGIAR partners. IFAD's support for CGIAR research has evolved towards a systems approach from an original focus on commodities and biophysical technologies appropriate to poorer farmers. This includes 1) developing methodologies for actively involving farmers in all stages of the research process within a framework that empowers rural communities, 2) environmental sustainability, 3) multi-disciplinarity,

4) multi-institutional partnerships and wide stakeholder participation, 5) gender-equity issues, and 6) technology validation and diffusion.

IFAD is the lead facilitating agency for establishing the Global Forum on Agricultural Research. It has led many initiatives that foster a progressive paradigm shift in agricultural research and development towards holistic, knowledge-intensive agriculture that mobilizes the knowledge and experience of scientists and small-scale farmers alike in innovative partnership. Furthermore, IFAD-financed loans, and the systematic linkages that research programs establish with them, provide both a platform for disseminating research outputs and the field context in which downstream research can be designed and adapted.

Rodney D. Cooke
Director
International Fund for Agricultural Development

A Diverse Harvest of Innovation

RICE research by the International Rice Research Institute in Asia developed varieties that resist diseases and pests, mature early, offer high yields, and so have had a major impact, particularly in India and Bangladesh.

WHEAT AND BARLEY research by the International Center for Agricultural Research in the Dry Areas (ICARDA) for farming systems in Central and West Asia and North Africa led to several drought-tolerant, high-yielding varieties being tested and adopted by farmers in at least 12 IFAD-supported projects.

MAIZE AND SORGHUM research by the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) and the International Center for Tropical Agriculture (CIAT by its Spanish acronym) on the mixed cultivation of maize and sorghum with leguminous crops led to successful sorghum varietal selection and seed provision for high altitudes, as well as broadly improving low-input rainfed production by poor farmers in Latin America.

FABA BEAN research by ICARDA led to dramatic yield increases in IFAD-financed and other projects, thereby contributing to self sufficiency in Egypt.

PIGEONPEA research at ICRISAT developed ICPH8, the world's first hybrid pigeonpea successfully bred for poor farmers.

CASSAVA research at CIAT and the International Institute of Tropical Agriculture (IITA) in Latin America and Africa identified and developed elite populations of cassava varieties for smallholder farms in drier subtropical areas. These successfully addressed drought tolerance, yield and dry-matter content, disease and pest resistance, and low content of toxic cyanogenic glycosides.

POTATO research by the International Potato Center led to white potato technology successfully adopted by small-scale farmers in North and West Africa, as well as the development of innovative diffused-light storage of seed potatoes and true seed-based potato production.

PLANTAIN research under small-farm conditions by IITA, a largely uncharted field of research, developed varieties resistant to black sigatoka disease, which has been crucial for safeguarding the future of plantains within African farming systems.

AGROFORESTRY development was first attempted in the Sahelian semi-arid lowlands through farmer participatory research led by the World Agroforestry Centre. IFAD also supported IITA as it moved development of **ALLEY FARMING** technology from research stations to farms.

FARMER-MANAGED IRRIGATION SYSTEMS are an innovation first supported by IFAD for small-scale irrigation schemes.

BIOLOGICAL CONTROL research that developed effective techniques, and facilitated their large-scale application through national institutions in Africa, is perhaps IFAD's best-known success. The Fund's support led to successful biological control of the destructive **CASSAVA MEALY BUG**, which had caused considerable damage to food crops in sub-Saharan Africa. IFAD's support for research by IITA and the International Centre of Insect Physiology and Ecology on the biological control of **CROP BORERS** in sorghum, maize and cowpeas had a profound beneficial impact on the production of poor farmers in Africa.

Mexico and the CGIAR: Collaborating to Combat Poverty

Mexico possesses very important biodiversity, as within its territory are found 10 percent of the world's major plants, more than 40 percent of which are endemic. This wealth has benefited agriculture in Mexico as well as in many other countries, as Mexico is the center of genetic diversity and domestication of several crop species of great importance to mankind such as maize, beans, sweetpotato and hot peppers, among others.

In congruence with this diversity, Mexico has been active in international cooperative efforts promoting development and has participated in mechanisms and institutions addressing agriculture, fisheries and rural development issues. Good examples of this are Mexico's participation in key international forums such as the Consultative Group on International Agricultural Research (CGIAR) and its collaboration with some of the Future Harvest Centers of the CGIAR. In particular, Mexico has hosted the International Center for the Improvement of Maize and Wheat (CIMMYT) since its foundation in 1967.

Joint activities with CIMMYT have been fruitful, enlisting science to support poor maize and wheat farmers in low-income countries so that they can develop more profitable, productive and sustainable maize and wheat production systems.

A highly successful example of collaboration is quality protein maize (QPM), whose research and development owes much to the participation of the Mexican scientist Evangelina Villegas. Obtained through conventional techniques of genetic improvement, QPM is now planted in 25 countries. It contains 20-30 percent more protein than ordinary maize and as much as twice the essential amino acids. QPM is therefore a food that will help to reduce malnutrition in impoverished communities in Mexico and many other countries.

Among national objectives for rural development, some are general in scope, such as the eradication of extreme poverty, and others are more specific, focusing on technological advances to increase agricultural productivity at reduced cost, to achieve or preserve competitiveness in open markets.

According to information available in 2004, there are 25.6 million people living in rural areas of Mexico, or 24.6 percent of the total population. National Employment Survey 2004 data show the agricultural sector employing 16.4 percent of the labor force and producing 5.3 percent of the Mexican gross domestic product. Productivity in the sector is thus less than a third as high as that of the national economy as a whole. Nowadays, 71.8 percent of agricultural producers are devoted to cultivating basic grains, while 7.1 percent produce coffee and 3.7 percent grow sugarcane.

In 2002, the Secretariat of Social Development classified 36 percent of rural households as poor on the basis of their income available for basic food consumption and health and educational services. The situation is particularly delicate in zones populated by indigenous people and households headed by women

Quality protein maize is a food that will help to reduce malnutrition in impoverished communities in Mexico and many other countries

and the elderly. This shows how important it is to link, in a more efficient manner, scientific research with the productive sector — and particularly with small-scale producers — with the aim of inducing economic impact that benefits the inhabitants of rural areas.

Despite the diverse accomplishments of the CGIAR Centers, achieved jointly with their partners in national agricultural research systems, it is imperative to widen the scope of the work performed by these Centers on scientific issues linked to socioeconomic issues, and to strengthen the linkages between scientific processes and their application in the productive sector. Particular attention should be paid to linkages with the poorest producers and so allow them to achieve higher development and a better standard of living.

While it is important to be mindful of the importance of science as an instrument for development, it is nonetheless also evident that scientific issues must be addressed within the framework of state policies and programs. In this regard, combating poverty and fairly distributing income constitute fundamental tasks with potential for development. At the same time that Mexico encourages working together with the CGIAR and its Centers, it also extends important efforts in several other fields affecting rural poverty. Mexico has reinforced its institutional structure and improved the regulatory framework for the agricultural sector, for example by promulgating laws promoting sustainable rural development and biosafety.

Mexicans emphasize the importance of reducing the gap between existing natural resource management and the possibilities for improvement that science provides according to the requirements of producers, especially less favored ones. This should be done in such a way that improvements can be incorporated to create better capacity to compete in international markets as well as provide food for domestic consumption.

Victor Manuel Villalobos Arámbula
Coordinator of International Affairs,
Ministry of Agriculture, Livestock, Rural Development, Fisheries and Nutrition, Mexico

Future Harvest Centers Of the CGIAR

Africa Rice Center (WARDA)
Headquarters: Cotonou, Benin
www.warda.org

Four varieties of New Rice for Africa specially bred for the lowlands are released.

Africa Rice Center Extends Upland Breakthrough to Lowlands

The original New Rice for Africa (NERICA) varieties were bred for the rainfed uplands of sub-Saharan Africa. Now the Africa Rice Center (WARDA) is developing new rice varieties for the African lowlands.

Called Lowland NERICAs, the new varieties are being developed in close partnership with national programs in West Africa through the West and Central Africa Rice Research and Development Network. These new varieties are poised to have an even bigger impact than upland NERICA because the lowlands, where rice is grown in bunded fields that are flooded for at least part of the growing season, offer great potential for sustainably intensifying rice farming in Africa.

However, lowland ecologies, which cover 20-50 million hectares in West Africa alone, pose a huge challenge for rice researchers because of their heterogeneity and such production constraints as lack of water control, iron toxicity, weeds, rice yellow mottle virus, African rice gall midge, stemborers and nematodes.

NERICA is a name (trademarked by WARDA in 2004) that is well known as a product whose rice varieties have been a breakthrough in the uplands. Less well known is that NERICA is also a technological process. At the heart of the technology is the successful crossing of two species of cultivated rice — *Oryza glaberrima* from Africa and *Oryza sativa* from Asia — to produce fertile plants that combine the best traits of both parents. From the Asian parent come high yields, from the African parent the ability to thrive in the challenging environments of Africa. A team of researchers from WARDA and its national partners are now successfully applying NERICA technology to breed hundreds of new varieties suitable for the various niche ecologies of the African rainfed and irrigated lowlands.

At the Africa Rice Center, Moussa Sié, a lowland-rice breeder, and Kouamé Miézan, an irrigated-rice breeder, have used the NERICA technology, in close partnership with national programs in West Africa, to cross varieties of African rice specifically selected for their resistance to lowland stresses with Asian varieties of proven popularity that are susceptible to these stresses. As with upland NERICA, breeding the new rice for African lowlands has posed a formidable scientific challenge because the two rice species evolved separately over millennia. Overcoming hybrid sterility requires careful backcrossing with *O. sativa* until fertility is restored.

Now available to farmers is a new plant type adapted to African lowland stresses. It offers a yield potential of 6-7 tons per hectare, responsiveness to nitrogen fertilizer, a growth duration of 120 days and acceptable plant height. About 60 varieties of lowland NERICA have been selected by farmers in several African countries through participatory varietal selection, an approach that successfully accelerated the dissemination of the upland NERICAs.

The new Lowland NERICA varieties are poised to have a big impact because the lowlands offer great potential for sustainably intensifying rice farming in Africa

CIAT Probes the Roots of Higher Fertilizer Efficiency

The forage grass *Brachiaria humidicola* holds the key to more efficient crop use of nitrogen fertilizer.

CIAT
Centro Internacional de Agricultura Tropical
International Center for Tropical Agriculture

Researchers at the International Center for Tropical Agriculture (CIAT by its Spanish acronym) and the Japan International Research Center for Agricultural Sciences (JIRCAS) are working to exploit a rare biochemical phenomenon that promises to make nitrogen fertilizer far more efficient to use, reducing costs, water pollution and greenhouse gas emissions.

Chemicals released from the roots of an African grass widely grown in South American pastures triggers biological nitrification inhibition (BNI). This slows the conversion of ammonium — the form of nitrogen in most commercial fertilizers — first into nitrite and then into nitrate and nitrous oxide. Nitrate is crucial to crop growth, but most of it leaches away, often to pollute streams and groundwater, and nitrous oxide is a powerful greenhouse gas. Slowing nitrification to a rate compatible with good crop growth would both reduce fertilizer needs and lessen agriculture's impact on the environment.

In 1982, a scientist at CIAT noticed that soil under the forage grass *Brachiaria humidicola* had more ammonium and less nitrate than expected. This observation eventually led CIAT and JIRCAS to collaborate on BNI research. The joint project, formally launched in January 2002, aims to get to the bottom of the BNI phenomenon and put it to practical use. The incentive to control nitrification is strong. Aside from the threat to the environment and human health, the direct cost of nitrogen loss in cereal production alone is US$16.4 billion per year.

Recent advances are promising. The JIRCAS team has perfected a test that identifies and measures the BNI trait. Joint work by JIRCAS and CIAT in 2004 showed that substances exuded from *B. humidicola* roots inhibit nitrification in soil and that the effect is long-lasting. JIRCAS has identified the chemical compound responsible for BNI in *B. humidicola* shoots and is working on identifying the compound released from the roots. JIRCAS researchers G.V. Subbarao and Osamu Ito believe that unraveling the mechanisms of BNI in *B. humidicola* will help in developing "smart" nitrogen fertilizers that do not undergo rapid nitrification.

> Slowing nitrification to a rate compatible with good crop growth would both reduce fertilizer needs and lessen agriculture's impact on the environment

In 2004, the CIAT team used the JIRCAS assay to screen 10 accessions, or plant samples, of *B. humidicola* from the Center's seed bank, discovering wide genetic variability with regard to nitrification inhibition. "We found three accessions of *B. humidicola* that have significantly greater capacity for NI than the standard cultivar Tully," reported Marco Rondón, a biogeochemist with CIAT's Tropical Soil Biology and Fertility Institute. Screening of more *B. humidicola* accessions and other grass species, as well as some crops, is underway at CIAT and JIRCAS. A field study is in progress in Colombia to further verify and characterize the BNI phenomenon.

Apart from conventional breeding to enhance BNI, researchers hope to isolate, sequence and clone BNI genes from *B. humidicola* and introduce them into field crops through genetic transformation. Building "fuel efficiency" right into the very genomes of major crops has enormous potential to cut both production costs and agriculture's share of greenhouse gas emissions and nitrate pollution of water.

Center for International Forestry Research (CIFOR)
Headquarters: Bogor, Indonesia
www.cifor.cgiar.org

The popular "fruit book" integrates traditional knowledge with research generated by 90 Brazilian scientists.

CIFOR Composes An Extraordinary Poem To Amazonia

Rural communities complain that scientific research is an extractive enterprise like logging and mining. Researchers take data but rarely share their findings with local folk. In the Brazilian Amazon, Patricia Shanley and Gabriel Medina, scientists from the Center for International Forestry Research (CIFOR), are determined that the results of their research on forest fruit trees and medicinal plants be returned to forest communities and so guide vital livelihood decisions.

After working with villagers for more than a decade, Dr. Shanley designed a 300-page book that can be "read" without letters. *Frutiferas e Plantas Úteis na Vida Amazônica* (Fruit Trees and Useful Plants in the Lives of Amazonians) integrates traditional knowledge with research generated by 90 Brazilian scientists. The "fruit book," as it is known, helps forest dwellers understand the real value of their forests, so they know which trees to sell and which to protect.

One illustration shows loggers offering villagers 2 reais (less than US$1) for an entire *bacuri* tree, the value of just a few *bacuri* fruit. Another shows a villager receiving $15 dollars for a mahogany tree as a cigar-smoking executive pays $10,000 for a boardroom table and chairs set. Ecology, nutrition and forest management are presented through pictures, farmers' stories, jokes, music and lore.

The question that prompted the research behind the book was posed by villagers along the logging frontier: "Is our forest worth more for its fruit, fiber, medicines and game, or for its timber?" Dr. Shanley discovered that the answer was elusive, as forest species critical to local livelihoods had received scant research attention. Tropical fruit production is highly variable, and little was known about the market or subsistence value of forest products. Over a 5-year period, hunters and the research team mapped fruit tree species over 3,000 hectares. Three communities weighed all of the fruit, fiber, game animals and medicines they consumed in 1993-94 and again after eight logging episodes in 2003-04.

With the book incorporated into an adult literacy initiative, villagers now learn better negotiation skills and improved forest management as they learn to read

"The book has helped us to recognize the value of our fruit, fiber and medicinal plants," commented Bene, an Amazonian hunter from the Capim River, at a book launch in December 2004. "We no longer sell trees to loggers for nothing."

Brazil's Ministries of Environment, Health, Culture and Education support the book's dissemination, as does *Fome Zero*, the presidential anti-hunger campaign. The Land Titling Bureau has incorporated the book into its PRONERA adult literacy initiative, so villagers now learn negotiation skills and improved forest management as they learn to read. By the end of 2004, over 1,000 literacy trainers knew how to use the book to reach an initial target of 14,000 adults. Nationally, the fruit book is helping to refocus forestry training toward livelihoods and non-timber forest products.

In the preface, Brazilian Minister of the Environment Marina Silva states: "This book is an extraordinary poem to Amazonia…providing information which is fundamental to realizing the dream of socially and environmentally just development." Beyond Amazonia, the book shows how science can empower rural people in the struggle against hunger and poverty.

If left unchecked, stem rust caused by *Puccinia graminis* could cause the loss of wheat worth US$9 billion or more.

CIMMYT

International Maize and Wheat Improvement Center (CIMMYT)
Headquarters: Mexico City, Mexico
www.cimmyt.org

CIMMYT Rallies to Halt Resurgence Of Stem Rust in Wheat

A new and virulent strain of stem rust from eastern Africa poses a great threat to world wheat production, according to Nobel Laureate Norman Borlaug. "If left unchecked," warned Dr. Borlaug, "it could cause the loss of at least 60 million tons of grain worldwide, worth US$9 billion or more, and threaten the food security and livelihoods of millions of smallholder farmers who cannot afford fungicides to combat the disease."

To mobilize scientific and financial resources to hold the new threat at bay, the International Maize and Wheat Improvement Center (CIMMYT by its Spanish acronym) has launched the Global Rust Initiative. "The key aim is to provide farmers with new, high-yielding varieties that resist this new race of stem rust, as well as other types of rust diseases," explained John Dodds, CIMMYT's deputy director general of research. "Participants will also help to re-establish a global warning and tracking system, revitalize international germplasm testing and training networks, and build broad, durable partnerships."

Scientific evidence, particularly the movement of yellow rust from the eastern African highlands to Asia during 1986-98, suggests that wheat lands in South Asia constitute a common epidemiologic zone connected to eastern Africa. Tests show that the new rust strain attacks many wheat varieties popular in these and neighboring regions. Prevailing winds could carry spores to Central and South Asia and eventually around the world, ravaging the harvests of hundreds of millions of farmers.

Dr. Dodds said the International Center for Agricultural Research in the Dry Areas will play a key role in the new initiative. Other partners will include national agricultural research systems, advanced research institutes, private companies, and non-governmental and civil society organizations. The Rockefeller Foundation, the Agricultural Research Service of the US Department of Agriculture, and the Sasakawa Africa Association have provided emergency support to CIMMYT to commence stem rust screening of global wheat collections in eastern Africa, in collaboration with the Kenya Agricultural Research Institute and the Ethiopian Agricultural Research Organization. Other donors and partners are discussing intermediate-term responses.

Wheat is grown on more than 200 million hectares worldwide and is a source of food and livelihoods for hundreds of millions in developing countries. Until the advent of science-based agriculture, world wheat harvests were held hostage by rapidly evolving fungal pathogens, among the most damaging of which were rusts. Modern breeding combined with the free international exchange of experimental wheat lines resulted in the development and wide distribution of wheat varieties able to resist rust pathogens for several decades. One result was that stem rust began to be seen as less threatening, and many wheat-breeding programs in developing countries stopped screening for rust resistance.

"The current crisis is a wake-up call about the continuing and potentially devastating impact that rust pathogens can have on susceptible cereals, especially for a staple food like wheat," Dr. Borlaug cautioned. "Plant breeders and pathologists still have time to screen for resistant genotypes and to get the varieties into farmers' fields, but there is no room for complacency."

We still have time to screen for rust-resistant genotypes and to get the wheat varieties into farmers' fields, but there is no room for complacency

International Potato Center (CIP)
Headquarters: Lima, Peru
www.cipotato.org

All participating farmers increased the area planted to improved sweetpotato varieties in the project's second year.

CIP Makes Sweetpotato Grown for Pigs Sweet Indeed

A simple but sophisticated technology is having a significant impact on livelihoods in China and Southeast Asia, where pork is a key source of protein. Most of the pork comes from poor backyard pig producers, many of whom grow sweetpotato for feed.

Pigs convert feed into meat very efficiently, and they like sweetpotato. However, pig nutrition on small farms is generally poor, and postharvest crop losses are high because the roots and vines store poorly. To make the sweetpotato edible, farmers must chop and boil the vines and leaves for 2 hours, which is labor intensive and time consuming, especially burdening women. It also uses precious fuel.

A technology developed by the International Potato Center (CIP by its Spanish acronym), by which pig feed is made from sweetpotato using ensilaging and local feed supplements, effectively increases productivity, according to research in Vietnam and Papua Province, Indonesia. CIP and its national agricultural research partners bred new varieties of sweetpotato that produce more dry matter and prolific vines and roots, resulting in at least 25 percent improvement in root yield. All farmers who planted an improved variety increased the area planted to it in the second year and established multiplication plots to ensure that they had enough planting material.

Farmers easily learn the simple ensilaging system and how to use feed supplements. As silage, the roots, vines and foliage can be stored as high-quality feed for up to 6 months. They need not be cooked, and the same amount of feed produces more meat. "Significant gains in productivity in smallholder pig production are possible with a modest investment in research and extension," observed Keith Fuglie, leader of CIP's Impact Enhancement Division.

This highly effective technology is a key element in work on sweetpotato-based pig-production systems in the uplands of China's Sichuan Province. Scientists from the Sichuan Animal Science Academy put improved sweetpotato varieties, developed by the Sichuan Academy of Agricultural Sciences with CIP, high on the list of options they offer farmers — together with CIP ensiling technology. This initiative of the International Livestock Research Institute is underway in Tianle and five other villages about 170 kilometers northeast of Chengdu.

Most farmers in Tianle are very poor, with an average per capita income of less than US$100 per year. Livestock contributes up to 80 percent of total farm income. The new technology has dramatically improved their prospects of a better life. "Last year I produced enough roots of the new variety not only to ensile and reserve seeds for this year's planting," said Liang Dongshen, one of the farmers, "but also to give 100 kilograms as presents to my friends and even to sell 500 kilograms."

This means that more pigs can be raised. "Last year Tianle village sold 300 pigs," reported village leader Liang Bo. "This year we sold 380 in the first quarter alone."

The technology is being extended in China with support from the Asian Development Bank, and to eastern Indonesia with help from the Australian Centre for International Agricultural Research.

Pig feed made from sweetpotato using silage and local feed supplements effectively increases the productivity of pig farmers in China and Southeast Asia

Research to improve olive cultivation and water harvesting makes marginal environments more productive.

International Center for Agricultural Research in the Dry Areas (ICARDA)
Headquarters, Aleppo, Syrian Arab Republic
www.icarda.org

ICARDA Conserves Water and Soil Under Olive Trees

The semi-arid areas of Central and West Asia and North Africa (CWANA) are harsh environments, often sloping and rocky with poor, shallow soils. Olive trees (*Olea europaea* L.) are well suited to these marginal environments. They have been grown in the region for over 5,000 years and remain of major importance to the livelihoods of rural communities.

Although 36 percent of the world olive area is in CWANA, the region contributes only 16 percent to global olive production. By contrast, southern Europe accounts for 72 percent of production, derived from only 55 percent of the area. Harsh climatic conditions and poor management practices explain the low productivity in CWANA. The International Center for Agricultural Research in the Dry Areas (ICARDA) is working with Syrian farmers and national agricultural research partners on simple techniques for managing soil and water in olive groves in marginal areas. ICARDA uses two complimentary approaches: farmer-participatory research and controlled experiments.

The Khanasser Valley in northwestern Syria has poor soils and annual rainfall of only 220 millimeters. The lower slopes of degraded hills are traditionally used for extensive grazing or barley cultivation. To secure their household needs for olive oil, farmers have converted this marginal land to olive orchards, despite it being too dry for the crop. Working with farmers, ICARDA is evaluating a range of Syrian olive cultivars for adaptation to this area, as well as techniques for harvesting water and reducing runoff, such as furrow-enhanced, V-shaped microcatchments to capture runoff. In stony or sloping groves, where tillage and machine operations are impossible, permanent water-harvesting structures are under consideration. ICARDA's research in 2004 showed that the structures can contribute 100 liters of water per tree each year, cutting summer irrigation costs by 10 percent.

Olives have grown in semi-arid areas of Asia and Africa for over 5,000 years, but the harsh climate and poor management practices keep productivity low

Afrin, also in northwestern Syria, is a hilly area with relatively good rainfall totaling 500-600 millimeters per year. Olives are the primary source of income. Farmers plow up and down sloping land because plowing along the contour is not possible with a tractor. This causes soil erosion, which is aggravated by the sparse canopy cover resulting from the farmers' severe tree pruning. To address this land-degradation problem, ICARDA, in cooperation with farmer groups, is implementing an integrated land-management research program.

A participatory experiment with Afrin olive farmers compares the effect of moderate annual pruning with severe pruning every second year. Moderate pruning maintains good canopy cover and ensures satisfactory olive production. Reducing tillage and leaving natural grass strips to grow along the contours between the trees decrease rainwater runoff. Also, intercropping with vetch improves soil fertility, reduces soil erosion and provides feed for livestock.

Farmers and researchers are working closely to facilitate quick adoption of the recommended practices. This research is helping to improve olive production in marginal dry areas of Syria and the livelihoods of the rural poor. As northwestern Syria is similar to other dry, marginal environments, ICARDA plans to scale out the research results to other areas of CWANA.

Hagaz, the project's first pearl millet variety resistant to downy mildew, outyields a traditional Eritrean cultivar.

ICRISAT Millet Partnership Is the Pearl of Eritrea

Pearl millet (*Pennisetum glaucum*) is grown in Eritrea on more than 80,000 hectares, mainly by small farmers in the lowlands and foothills. It is the second most important cereal in the country after sorghum. Farmers grow traditional landraces, which have many preferred traits but provide modest yields and, in general, are susceptibile to downy mildew.

Downy mildew disease, caused by the fungus *Sclerospora graminicola*, is a major production constraint for most of the semi-arid tropics. The disease is widely distributed in Eritrea. In 1999 and 2000, 30-50 percent of the plants in most pearl millet areas surveyed in the Anseba and Gash Barka regions were infected with downy mildew. The disease causes major yield reductions, estimated to be as high as 30 percent in Anseba in 2000.

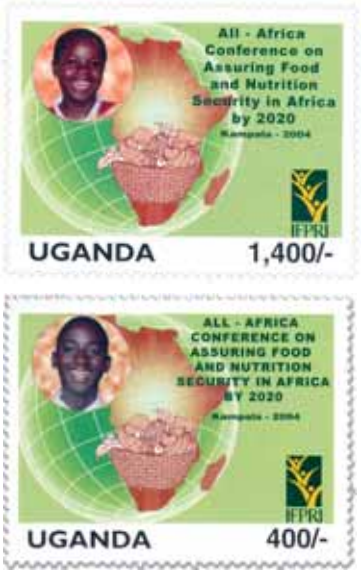
The Eritrean pearl millet variety Hagaz, released in 2004, is the first product of a type of partnership that the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) sees as a model for its future work in Africa. The partnership links ICRISAT with the Eritrean National Agricultural Research Institute. It began in 1998 when Negusse Abraha, an Eritrean millet breeder, did his dissertation research at ICRISAT for his masters degree in plant breeding.

When Mr. Negusse returned to Eritrea, ICRISAT helped him to develop a breeding program designed to improve Eritrean landraces and to breed new varieties. The Eritrean Millet Program made crosses between selected local landraces, which were locally adapted and valued by farmers, and ICRISAT varieties and populations that provided disease resistance and a higher yield potential. The Program has enjoyed generous funding initially from the Danish International Development Agency and, since 2002, from the Syngenta Foundation for Sustainable Agriculture, including funding of technical support activities by ICRISAT such as visits to the breeding nurseries and on-farm trials, equipment, supplies and advice.

Hagaz, bred from a cross between the Eritrean landrace variety Tokroray and the ICRISAT variety ICMV221, was identified from the first set of 25 population crosses, made in 2000, for its superior grain yield and downy mildew resistance. It has an infection rate of 1 percent, against 38 percent for Tokroray. In on-farm trials conducted in 2001 and 2002, the cumulative mean grain yield across all environments at 41 sites in Anseba and Gash Barka showed that Hagaz was clearly superior to the local landrace.

The development of Hagaz, which is named after the location where the crosses were first made, has proceeded in parallel with the expansion of the Eritrean Millet Program itself. Beginning with plant breeding at the research station, the Program advanced to on-farm trials run collaboratively with the extension service, and then to the production of foundation seed to support the production of certified seed by small farmers. The Program's success is a tribute to a small but effective partnership joining three organizations that share the common objective of providing Eritrean farmers with the technologies to improve their livelihoods.

Millet breeders crossed selected local landraces, which were locally adapted and valued by farmers, with Institute varieties that provided disease resistance and a higher yield potential



Uganda issued special stamps to carry the messages of the groundbreaking all-Africa conference around the world.

IFPRI Catalyzes African Food and Nutrition Security

Some breakthroughs take place in the laboratory or the test plot, others in the minds of people. In 2004, the International Food Policy Research Institute (IFPRI) facilitated an all-Africa conference that brought unprecedented attention to the linked issues of hunger and malnutrition in Africa, the continent's most fundamental challenge. "Assuring food and nutrition security in Africa by 2020: Prioritizing actions, strengthening actors and facilitating partnerships" took place in Kampala, Uganda, in April 2004. It was facilitated by IFPRI through its 2020 Vision Initiative, cohosted by the government of Uganda, and cosponsored by more than a dozen organizations.

The conference had enormous scope. More than 500 participants came from 51 countries to discuss how to catalyze change and action to assure food and nutrition security in Africa. The sessions took stock of the African food and nutrition situation and identified institutional and political strategies and solutions. Participants examined how to strengthen key actors and facilitate partnerships between them.

Participants included policymakers and advisors, parliamentarians, key actors in nongovernmental and community-based organizations, business leaders, heads of regional organizations, farmers, researchers and academics, directors of international agencies, and the media. Keynote addresses, plenary sessions and parallel sessions featured more than 110 speakers, chairs, panelists, moderators and rapporteurs. Speakers included the Ugandan, Nigerian and Senegalese heads of state, one former head of state, one current and one former first lady, two Nobel Prize winners and several World Food Prize laureates. Several heads and senior staff from Centers spoke or attended, and Kanayo F. Nwanze, director general of the Africa Rice Center, served on the conference advisory committee. The 3 days of discussions were lively and intense, informing and energizing participants to catalyze action.

> The conference identified institutional and political strategies and solutions to strengthen key actors and facilitate partnerships between them

Several follow-up activities have spread the word about the outcomes achieved. In addition to generating broad media coverage at the time, the conference has led to many publications, including briefs, discussion papers and a comprehensive proceedings volume. Uganda issued a special postage stamp to carry the conference messages around the world.

The advisory committee summarized conference recommendations in *A Way Forward*. This document, distributed at the end of the conference, and the conference proceedings have been shared extensively with decision makers and other stakeholders throughout Africa. The advisory committee members took the lead in briefing the three attending African heads of state, and President Yoweri Kaguta Museveni of Uganda briefed other African heads of state.

Committee members have mainstreamed the results in their own networks and forums, briefing African regional organizations such as the Economic Community of West African States and the Common Market for Eastern and Southern Africa. Conference results served as input to the work of the Commission for Africa.

International Institute of Tropical Agriculture (IITA)
Headquarters: Ibadan, Nigeria
www.iita.org

IITA
Research to Nourish Africa

Plantain and banana growers need clean planting material and appropriate methods for reducing nematode infestation.

IITA Offers Clean Start For Bananas and Plantains

Most farmers of bananas or plantains in Africa have a few hundred plants on a small field. Plants produce few suckers, or secondary shoots, and natural regrowth is slow. This makes material for planting scarce. So, when soil fertility is depleted or nematodes infest the field, farmers carry contaminated planting materials from the old field to a new site. This need not be the case. Available technology can increase the suckering rate to produce large quantities of pest-free planting material.

Promoting clean planting material and appropriate methods for reducing renewed nematode infestation is a cornerstone of a research program pursued by the International Institute of Tropical Agriculture (IITA) in support of plantain and banana growers.

Commercial seedling production by private individuals and nongovernmental and community-based organizations has already begun in Cameroon and Nigeria

The biology of the plant determines regeneration. Before flowering, the mother plant uses a form of hormonal control called apical dominance to suppress the development of lateral buds that would otherwise develop into suckers. Suppressing apical dominance breaks this dormancy.

IITA has developed methods that can increase sprouting to 9-14 suckers per year. This is done by manipulating the meristem, from which grow the leaves that form the pseudostem, or false trunk, of the banana "tree," which is actually a very large herb. Manipulation consists of either cutting down the entire pseudostem or cutting a window through the meristem. The foliage will then stay alive for about 3 months. These field techniques suit smallholder farmers who need small quantities of suckers.

The detached-corm method is suitable for enterprising farmers who want to produce commercial quantities of planting material. It works by activating latent buds under high humidity. The corms, or underground stems, of preflowering or harvested plants can be used, as can suckers from field-induced multiplication. As many as 100 more seedlings can be produced by this method than under field conditions. Scarring the lateral buds increases the number of seedlings by a factor of 2-10. Plantlets thus produced are, like tissue-cultured seedlings, uniform and less prone to post-establishment stress. This method requires a modest investment to set up humidity chambers and weaning facilities.

Adoption prospects for the detached-corm method are very high with the emergence of commercial production. This has already begun in Cameroon and Nigeria, where it is undertaken by private individuals and nongovernmental and community-based organizations. Selling suckers can be almost as lucrative as selling bunches.

These new technologies are user-friendly and offer high rewards for investment in extra labor or low-cost infrastructure. Joseph Ilesanmi is one farmer IITA works with to demonstrate the new technology. A resident of the town of Ajaye in the Nigerian state of Ekiti, Mr. Ilesanmi recalled his own reluctance to begin. "I felt half-hearted about using part of my farm for the experiment," he admitted. "I thought it wouldn't work. But what has come out of it is unbelievable."

Until recently, officials ignored smallholder dairying, which creates two full-time jobs for every 100 litres of milk produced.

ILRI

International Livestock Research Institute (ILRI)
Headquarters: Nairobi, Kenya; Addis Ababa, Ethiopia
www.ilri.org

ILRI Research Supports Pro-poor Dairy Policy Shift

An award-winning 8-year collaboration has helped millions of Kenyans beat poverty and malnutrition. It has done this through research on the country's small-scale dairy workers. Modest dairy enterprises, comprising households with one or two milk cows and young men with bicycles who hawk raw (unpasteurized) milk, account for 85 percent of the milk marketed in Kenya. This is an astonishing figure considering that per capita milk production and consumption in Kenya are among the highest in the world, and that Kenyan milk comprises 70 percent of total dairy production in eastern and southern Africa.

Smallholder dairying creates regular incomes for hundreds of thousands of poor Kenyans and creates two full-time jobs for every 100 liters of milk produced. Informal dairying thus dwarfs Kenya's modern dairy sector, yet this vast informal milk sector was, until recently, virtually ignored by national dairy policy, which viewed the trade as illegitimate.

Scientists conducting the Smallholder Dairy Project combined scientific research and expertise in government policymaking, international development and social activism to bring about a pro-poor shift in dairy policy. The project was led by Kenya's Ministry of Livestock and Fisheries Development, jointly implemented by the Kenya Agricultural Research Institute and the International Livestock Research Institute, and largely funded by the British government's Department for International Development. These organizations succeeded in putting into practice action research by working closely with government and regulatory bodies, the private sector, civil society organizations, and the country's formal and informal milk sectors.

The Smallholder Dairy Project developed technologies such as disease-resistant fodder varieties, research-based guidelines for milk hygiene, and a milk container affordable to the poor. Of greater import were the proposed national policy changes scientifically supported by project research and now being written into the Kenya Dairy Act. These promise to create an enabling policy environment for micro-sized dairy enterprises.

Project data show that almost all households in Kenya boil milk before consuming it, indicating that raw milk presents no substantial public health hazard. This reliable information helped establish small dairy producers and milk traders as successful and credible agents in the eyes of Kenyan dairy policymakers and regulators, who are now, in the words of the permanent secretary of the livestock ministry, "mainstreaming the raw milk market." The new policies will, for example, allow Kenya's 1.8 million informal dairy workers to be licensed and thus brought into the formal economy for the first time.

The project is helping to harmonize regional dairy policies through networks such as the Eastern and Central Africa Program for Agricultural Policy Analysis under the Association for Strengthening Agricultural Research in Eastern and Central Africa. And the project's approaches are proving useful beyond the region, such as in the northeastern Indian state of Assam. Small-scale dairying occupies 97 percent of the dairy market there and so has the potential to lift millions out of poverty.

New policies will allow Kenya's 1.8 million informal dairy workers to be licensed and thus brought into the formal economy for the first time

International Plant Genetic Resources Institute (IPGRI)
Headquarters: Rome, Italy
www.ipgri.org

Knowledge of the banana genome will facilitate improvement of this usually sterile cultivar through genetic transformation.

IPGRI Pools Resources On the Banana Genome

Bananas, especially cooking bananas and plantains, are vital staple foods and sources of income for hundreds of millions of people in developing countries. Diseases constantly threaten production, yet conventional breeding for resistance is constrained because most cultivars are sterile. Meanwhile, genetic transformation has been slowed by a lack of basic knowledge of the banana genome. Unable to command the sort of resources that enabled researchers to sequence the rice genome rapidly, banana scientists are pooling their resources in the Global Musa Genomics Consortium, which now comprises a score of member organizations from 15 countries.

Coordinating the Consortium is the International Network for the Improvement of Banana and Plantain program of the International Plant Genetic Resources Institute. Its step-by-step approach is starting to pay off with an improved understanding of the banana genome.

Cultivated bananas originated in different ways from two wild species. The dessert and cooking bananas that are the staple food in the highlands of East and Central Africa are seedless triploid derivatives of *Musa acuminata*. Most other cooking bananas and plantains, also seedless, descend from crosses between *M. acuminata* and *M. balbisiana*. Bacterial artificial chromosome (BAC) libraries derived from sterile cultivars and fertile diploid *M. acuminata* and *M. balbisiana* are a basic shared resource of the Consortium.

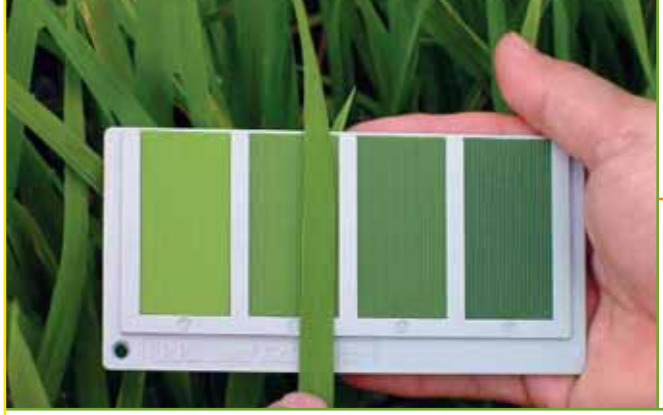
BAC clones sequenced by Consortium partners show that the *M. acuminata* and *M. balbisiana* genomes are very similar. There is also some microsynteny with rice, meaning that stretches of the *M. acuminata* genome contain the same genes, in the same order, as stretches of the rice genome.

Although the banana genome is relatively small, its chromosomes are difficult to distinguish from one another. At the Institute of Experimental Botany in the Czech Republic, where the Consortium's Musa Genome Resource Center is located, fluorescence in situ hybridization studies with labeled BAC clones and DNA probes now permit the identification of all 11 chromosomes of *M. acuminata*. The possibility of localizing BAC clones from *M. acuminata* on chromosomes of *M. balbisiana*, and vice versa, opens the way for comparative physical mapping. This will permit analysis of chromosome behavior and segregation during evolution and in-breeding programs.

The Institute for Genomic Research (TIGR) recently sequenced the ends of some 3,000 BACs. This allowed researchers to match *Musa* sequences against those of other plant species already in databases. Comparison with the rice genome indicated three possible syntenic matches to each of *Musa* chromosomes 4 and 10, and one to chromosome 8. In the next stage, TIGR will use whole-genome shotgun sequencing to gain broader insights into the overall organization of the banana genome.

Although this research has a long way to go, the Consortium has made considerable progress with limited resources. Its members actively participate in the Generation Challenge Program, which is developing a common set of markers for better characterization of banana genetic resources, and support further genomics studies comparing banana and rice. The end result will be improved banana varieties better able to withstand pests and diseases.

The Global Musa Genomics Consortium has made progress toward understanding disease-resistance in bananas and plantains



Fertilizers are most efficient when applied in amounts that complement naturally occurring nutrients.

IRRI

International Rice Research Institute (IRRI)
Headquarters: Los Baños, Philippines
www.irri.org

IRRI Tailors Nutrient Management To Crop Need

Rice farmers have long used leaf color as a subjective sign of their crops' nitrogen status. To help them monitor it objectively, and so better synchronize nitrogen applications to the plants' changing need, the International Rice Research Institute and the Philippine Rice Research Institute developed, from a Japanese prototype, a leaf color chart. The chart's color panels are veined to reflect light as rice leaves do, to ensure a close match. Pasted on the back is a simple instruction sheet in the local language.

Simple, easy to use and costing less than US$1 each, the leaf color chart is an excellent tool for crop nitrogen management. In the decade to 2004, more than half a million leaf charts were distributed to farmers, mostly in Asia but also in Africa and Latin America. Accompanying the spread of the charts has been knowledge of site-specific nutrient management (SSNM).

The nutrients rice plants need come mainly from soil, crop residues and irrigation water. However, these naturally occurring, indigenous nutrients are typically insufficient to meet the needs of rice grown for high yield. Nitrogen, phosphorus and potassium are the nutrients rice requires in the largest quantities. SSNM offers farmers an effective approach for feeding these supplements to rice, as and when the crop needs them. Applying nutrients at optimal rates and times improves their uptake and so maximizes the value of the harvest per unit of fertilizer invested, while reducing fertilizer runoff and pollution.

The SSNM approach uses nutrient-omission plots to determine the phosphorus and potassium fertilizer requirements for a given soil type or rice-growing area. Farmers calculate the deficit between the crop's need, determined by the yield in a plot of rice grown with abundant fertilizer, and the indigenous supply, determined in plots with one nutrient not supplemented. The optimal rate of supplementation fills this deficit and includes sufficient phosphorus and potassium to prevent soil depletion arising from their removal in grain and straw. Farmers practicing SSNM supply all phosphorus fertilizer in one early dose because it is vital for young plant growth. Potassium, on the other hand, is needed later to improve grain filling and resistance to diseases and lodging, so farmers often apply a second dose at early panicle initiation.

In 2003-04, SSNM was evaluated and promoted with farmers at diverse locations in tropical and subtropical Asia, each typical of an intensive rice farming area of more than 100,000 hectares. Results indicate that many irrigated rice paddies receive excess nitrogen during early crop growth, when crop demand for it is small, and insufficient nitrogen at later growth stages such as panicle initiation, when demand is large. Some rice farmers do not supply enough potassium fertilizer. Excess early nitrogen and insufficient potassium fertilizer can make rice more susceptible to diseases and insect pests. Improved management of nitrogen and potassium fertilizer through SSNM reduces disease and insect damage, thereby curtailing the need for costly pesticides.

Applying nutrients optimally improves their uptake and the value of the harvest per unit of fertilizer invested, while reducing runoff and pollution

International Water Management Institute (IWMI)
Headquarters: Battaramulla, Sri Lanka
www.iwmi.cgiar.org

Cadmium contamination stems from irrigation water drawn from a river that passes through a mineralized zinc deposit.

IWMI Illuminates Water-borne Health Risk in Rice

Cadmium contamination of crops from industrial run-off or natural mineral deposits poses a serious threat to human health. Consuming cadmium-tainted crops like rice over the long term is known to cause irreversible kidney dysfunction. In addition, high levels of heavy-metal contamination can influence the long-term sustainability of soil and water resources, as well as negatively impact trade and the economy. Many reports on the health effects of cadmium have emerged from Japan, China and Southeast Asia, where rice lands have become contaminated with cadmium by irrigation water tainted by natural causes or discharges from mines, smelters and associated facilities.

The Southeast Asia regional office of the International Water Management Institute (IWMI) and the Royal Thai government's Department of Agriculture and Land Development are carrying out an in-depth assessment of cadmium contamination of rice and associated rotation crops in Thailand. The study, which began in 2001 and continues in 2005, is taking place in an area of the Thai-Myanmar border where exposed deposits of zinc are mined. Cadmium is often an accessory mineral in base-metal deposits.

Initial studies showed that rice has a propensity to accumulate in the grain high concentrations of cadmium but nutritionally insignificant amounts of zinc and iron. Maize grown on similarly contaminated sites does not accumulate cadmium to the same extent. The difference is associated with the cycles of wetting and drying often observed in paddy rice production.

Results from grain surveys in the area showed that rice grain harvested from 2,000 hectares of land contained cadmium levels that exceeded international norms. The contamination of the paddy fields stemmed from suspended sediments in irrigation water drawn from a river that passes through the mineralized zinc deposit. Researchers developed a simple but effective risk-assessment model that predicts cadmium distribution within a cascading irrigation system, and this is being used to predict — without extensive, labor-intensive soil sampling — the degree of contamination in irrigated fields.

The study outcomes have underpinned the government's response to the cadmium-contamination crisis and led to the development of comprehensive action plans

IWMI and its Thai partners identified and zoned high-risk fields within the affected communities. The study outcomes have underpinned the government's response to the crisis and led to the development of comprehensive action plans. In the short term, these have included confiscating and destroying over 7,000 tons of contaminated rice, paying US$1.5 million to 600 farm households as compensation for crop losses, and instituting a ban on growing crops for human consumption in highly contaminated areas. For the long term, adjusting cropping patterns and growing non-food crops are among the practices being promoted in the affected areas. These measures will minimize the potential long-term health risks associated with cadmium contamination.

It is important to note that the study areas are small, isolated and regionally distinct, and that cadmium concentrations found in rice grain samples collected from this study area are not indicative of the Thai rice harvest as a whole.

World Agroforestry Centre
TRANSFORMING LIVES AND LANDSCAPES

Fertilizer trees allow Estere Banda, a widow in central Malawi, to grow enough maize to feed her family without food aid.

World Agroforestry Centre (ICRAF)
Headquarters: Nairobi, Kenya
www.worldagroforestrycentre.org

World Agroforestry Trees Spin Fertilizer From Air

The fertilizer tree concept developed at the World Agroforestry Centre was among a number of appropriate technologies highlighted in the recent report *Investing in Development: A Practical Plan to Achieve the Millennium Development Goals.* Jeffrey Sachs, Millennium Development Goals special advisor to the United Nations secretary-general, noted that fertilizer trees could play a major role in boosting food production and restoring Africa's degraded farmlands. This would contribute to achieving the goal of eradicating poverty and hunger.

Fertilizer trees can capture more than 100 kilograms of atmospheric nitrogen per hectare and transfer it to the soil. At those levels, farmers can readily double or triple their maize production without buying expensive mineral fertilizer.

Since the late 1990s, the technology has spread from just a few hundred farmers, who began village-level testing of the trees in eastern and southern Africa, to an estimated 200,000 maize farmers. The farmers recognize that fertilizer trees do much the same job as conventional fertilizers — improving soil fertility — but accomplish it using natural processes at a fraction of the cost. While World Agroforestry Centre researchers acknowledge that mineral fertilizers have a major role to play in African agricultural development, these products are frequently beyond the reach of the rural poor and are often unavailable even when subsidized by the government.

The significance of the fertilizer tree concept is that it enables a farm family to produce its own nitrogen and cycle other nutrients from deep within the soil with no outlay of cash. Fertilizer trees can be viewed as small fertilizer factories conveniently placed in the fields where the fertilizer is needed. They are also a one-time investment. Once the trees are established, seed multiplication and extension activities can be left in the hands of local communities.

While no one type of fertilizer tree fits all ecologies or production systems, demand is especially high for a leguminous species euphoniously called *Gliricidia sepium* or sometimes quickstick. Starting in the late 1980s, a particularly productive and robust variety of *Gliricidia* was introduced to Africa from Central America and tested. While the amount of fertilizer it produces is equal to that of other fertilizer trees species, its major advantage is that it grows back year after year despite severe pruning. This enables it to be planted and sustained at high density in a grid pattern. Before a maize crop is planted, the *Gliricidia* is trimmed right down to the ground surface so it will not compete with the maize.

Selected by cooperating farmers, *Gliricidia* performs well on both heavy and sandy soils and is widely adaptable. The nitrogen content of the foliage is 3-4 percent and provides a high-quality fertilizer that is readily taken up by cereal crops. Another important attribute is that *Gliricidia* produces lots of firewood. This reduces pressure on surrounding forests and woodlands, as well as saving families the time and labor they would otherwise need to invest in gathering firewood and carrying it back to the farm.

Fertilizer trees can be viewed as small fertilizer factories conveniently placed in the fields where the fertilizer is needed

Aquaculture farmers trebled their fish production and earned a return of more than double their investment.

WorldFish Helps Rice Farmers Diversify Production

The WorldFish Center has worked in Bangladesh since 1989, focusing mainly on small-scale aquaculture and participatory management. Collaboration with the Bangladesh Fisheries Research Institute over the past 15 years has seen the development and testing of many transferable aquaculture technologies.

The ongoing Development of Sustainable Aquaculture Project (DSAP), funded by the US Agency for International Development and other Members of the Consultative Group on International Agricultural Research, aims to improve Bangladeshi smallholders' livelihoods by helping them take advantage of improved ways to farm inland water resources. While continuing applied research on aquaculture technologies, DSAP trains local NGOs and their extension staff to disseminate to large numbers of smallholders improved aquaculture technologies, integrating aquaculture and agriculture by culturing fish in rice fields, for example, and demonstrating the advantages of polyculture over monoculture. The project also provides some training support to aquaculture-related small businesses such as hatchery owners, managers and seed sellers.

DSAP implemented more than 43,500 aquaculture demonstrations between 2000 and 2004 and is implementing 11,300 new demonstrations in 2004-05. The project has provided training to 517 extension workers from 48 NGOs and training support to 477 staff members from over 170 NGOs during the same period. In 2003, aquaculture demonstration farmers produced average harvests of 2,460 kilograms of fish per hectare in ponds, nearly tripling the production level that existed before the project. Economic analysis showed that each Bangladeshi taka invested in fish culture resulted in a gross benefit of 2.29 takas in ponds and 2.03 takas in paddies.

The project improves Bangladeshi smallholders' livelihood by helping them take advantage of improved ways to farm inland water resources

The story of Shafiqul Islam illustrates the project's operations and benefits in human terms. He lives in a household of 13 family members in a remote village in the Mymensingh District of Bangladesh. Having heard about DSAP through the Social Association for Rural Advancement (SARA), an NGO, he attended the aquaculture foundation training course. There he learned about profitable methods of fish culture in rice fields and income diversification by growing fruit and vegetables on the surrounding dikes.

Mr. Islam made a small ditch in a corner of his 0.22 hectare plot. A field assistant from SARA visited regularly and provided technical advice. With the help of his brothers, Mr. Islam transplanted the high-yielding rice variety BRRI Dhan-28, collected papaya seedlings and planted gourd seeds on the dikes. When the rice plants were a month old, he stocked his paddies with fingerlings of local fish species such as *rohu, katla*, common carp, silver carp and *sharputhi*.

Three months after planting, the family was able to start collecting leafy vegetables and gourds for household consumption and to market. They harvested 298 kilograms of rice, 74 kilograms more than in previous years. They started harvesting fish, some to eat and some to sell. After deducting expenses for the rice-field preparation, fertiliser, transplantation, fish stocking and vegetable cultivation, the net profit in 2003 from the rice-fish and dike cropping was 10,940 taka, or US$170. This was considerably more than Mr. Islam had made in previous years.

a global cgiar

Placement markers are approximate and indicate city locations, not worldwide offices.

- CGIAR Members
- CGIAR Supported Centers
- CGIAR Regional Offices