IITA

Research to Nourish Africa

Annual Report 2011

www.iita.org

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Cover photo: Women farmers of Jalino community in Borno State, Nigeria during a participatory appraisal exercise. Through our R4D initiatives and with partners, we promote the active participation of women in planning and decision making in agriculture especially in the rural areas.

Photo by: Bernard Haven, CIDA Development Office, Nigeria Program

IITA Annual Report 2011

Our Vision

To be Africa's leading research partner in finding solutions to hunger and poverty.

A farmer in Uganda making his way home after a hard day's work in the field. Photo by JT Oliver, IITA.

Who we are

Africa has complex problems that plague agriculture and people's lives. We develop agricultural solutions with our partners to tackle hunger and poverty. We are an international non-profit R4D organization established in 1967, governed by a Board of Trustees, and one of 15 international agricultural research centers supported by the CGIAR. Our award winning research for development (R4D) is based on focused, authoritative thinking anchored on the development needs of sub-Saharan Africa. We work with partners in Africa and beyond to reduce producer and consumer risks, enhance crop quality and productivity, and generate wealth from agriculture.

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From the Director General

Possibilities, potentials, and positive changes

At the final interview of the selection process for the position of Director General of IITA, one of the members of the interview panel asked me, "So, what is your vision for IITA?"

The question – short, pointed, and straight as an arrow – is probably the most important that can be asked of any candidate vying to be the head of the largest agricultural research-for-development organization in sub-Saharan Africa. My response, outlined in my presentation "Realizing the Possibilities" during that interview and summarized below, presents strategies for operationalizing my vision for the institute in the next 10 years.

Deeply committed to IITA's vision of "being Africa's leading research partner in finding solutions to hunger and poverty," I intend, as Director General, to organize and strengthen our research and research partnerships, building on our achievements and enhancing our scientific and administrative capacity to help resource-poor farmers boost production, improve food security, and increase incomes.

By 2020, we will be operating through decentralized and well-integrated research programs working on major challenges in Africa's food and agricultural sector specifically on crops and natural

resources linked to human wellbeing. We will also be carrying out our mission through programs aligned to and part of the larger CGIAR Consortium Research Programs (CRP), and fostering innovative partnerships and catalyzing relationships between and among international agricultural research centers (IARCs), national, regional and pan-African entities, the private sector, and farmer organizations.

We will also build on scientific advances and better understanding of the socioeconomic environment to enable farmers to triple yields, enhance crops' nutritional value, and promote greater commercialization of the food crops that we work on. We will achieve this by optimizing the use of natural and related resources while preserving the environment for future generations. To do this, we will have to double the human and financial resources currently available to us.

Well-defined strategic interventions – some related to the four strategic System Level Outcomes of the new CGIAR of reducing rural poverty, increasing food security, correcting undernutrition, and promoting more sustainable management of natural resources – will serve as our guiding light toward achieving our goals.

In the short-term, I will quickly work on the following priorities: revamp the natural resource management research area and establish the biotech platform for West Africa; decentralize the R4D program area along the Impact Zones, with the CRP on the Humid Tropics as the operating and

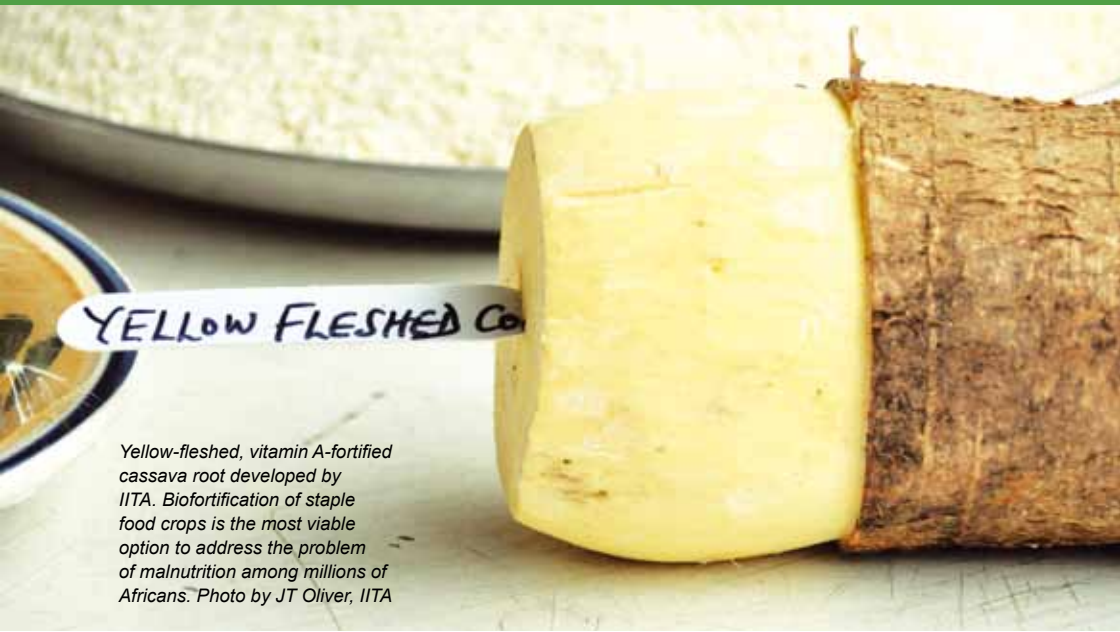
integrating arm; bring in strong and resource-winning Impact Zone research directors and the next generation of process-based and development and impact-oriented scientists; finalize the alliance with icipe and CIAT-TSBF to establish a CGIAR-based African center; strengthen relationships with other IARCs and CGIAR centers; and engage the private sector, where possible, for farm input supply and within the value chains of cocoa, cassava, and soybean.

I will engage the Board's unique talents, skills, and abilities to continually assess our strategies, devise smart solutions to adapt to new challenges and opportunities, and ensure that we maintain exemplary performance on all the strategic interventions. And all these, I will carry out with transparency as a leadership imperative.

As Director General, I pledge to exert all efforts to position IITA as the primary driver of "bringing new agriculture for a wealthier Africa," and it will be my great honor and pleasure if you will join me in this challenging but worthwhile and wonderful journey.

Nteranya Sanginga
Director General

Research Highlights



Yellow-fleshed, vitamin A-fortified cassava root developed by IITA. Biofortification of staple food crops is the most viable option to address the problem of malnutrition among millions of Africans. Photo by JT Oliver, IITA

Agriculture and Health

Micronutrient deficiency, particularly of vitamin A, zinc, and iron, is a major public health problem affecting mostly women and children. Food-borne diseases, mycotoxins, plant toxins, and poor management practices in intensified agriculture are responsible for associated diseases and can impose barriers to trade.

We address these major challenges by finding ways to provide a higher diversity and density of micronutrients in human diets, reduce food toxins, increase the knowledge on nutrition patterns and distribution of food and nutrients within social systems particularly with respect to human nutrition across social strata and gender, and overcome labor force bottlenecks in farms and households affected by HIV/AIDS or malaria through appropriate technologies.

Tackling killer aflatoxins in African crops

Contamination by aflatoxins of food crops is a global issue that is undermining public health and development efforts. In humans, aflatoxins increases disease susceptibility by suppressing the immune system, stunts children's growth, and causes cancer and death from acute poisoning through liver cirrhosis/necrosis. Aflatoxins also severely impact livestock through contaminated feed, causing death, slower growth, reduced feed conversion, and lower yields.

Aflatoxins are also non-tariff barriers to global trade since food crops that are contaminated above the limits set by importing countries are banned or rejected. Around 25 percent of the world's food crops are affected, with more than 5 billion people in developing countries, particularly in Asia and Africa situated between 40°N and 40°S, most at risk of chronic aflatoxin exposure.

Farmers in Burkina Faso inspecting a contaminated maize cob. Photo by J Atehnkeng, IITA.

Aflatoxins are produced by the fungi *Aspergillus flavus* when these infect both staple and export crops. However, not all strains of the fungus are

bad and produce the toxins. There are also benign ones – non-toxic or 'atoxigenic' – that, when used in a biocontrol technology and introduced at a particular stage of the crop, could outcompete and reduce the population of the toxic ones, thereby drastically reducing contamination.

Close up of some aflasafe granules sporelating in a groundnut field. Atoxigenic A flavus *fungi in aflasafe outcompetes its toxic cousins in affected fields, thereby reducing aflatoxin contamination. Photo by R Bandyopadhyay, IITA.*

We have been working on the biocontrol of aflatoxins for several years, successfully developing and deploying the biocontrol product aflasafe™ with the support of the Agriculture Research Service of the US Department of Agriculture (USDA-ARS). In the last two years, we consolidated efforts on biocontrol of aflatoxins with partners in Nigeria, Burkina Faso, Senegal, and Kenya. We also initiated a new biocontrol program in Zambia and secured funding for expansion of biocontrol activities in Mali, Ghana, and Tanzania for 2012 and beyond.

This year, we launched two projects in Nigeria, Kenya and Zambia that sought to provide farmers with a natural, safe, and cost-effective solution to aflatoxin contamination in maize and peanut.

In Kenya, we identified four competitive atoxigenic strains isolated from Kenyan maize to constitute a biocontrol product called aflasafe-KE1™. We are currently gathering efficacy data in areas

A Zambian child taking maize from a local storage structure. The protection offered by aflasafe extends from the field to postharvest storage, ensuring that crops are safe to eat. Photo by T Dubois.

where the technology will be deployed in Kenya.

In Zambia, the project will also develop a country-specific biocontrol product, but initial focus is on mapping the incidence of aflatoxin in maize and groundnut. In Nigeria, where the biocontrol technology is most advanced, we are exploring opportunities for commercialization of aflasafe™.

In Senegal, we coordinated the evaluation of a biocontrol product – aflasafe-SN1 – in 2010 and 2011, which involved 80 groundnut farmers. Fields treated with aflasafe-SN1 showed 90% reduction in aflatoxins compared to those that were left untreated.

In Burkina Faso, we screened more than 3,500 *A. flavus* isolates, and selected eight native atoxigenic strains that were evaluated in 30 maize and groundnut farms. From these eight, we will identify the four most effective strains to constitute aflasafe-BF1.

The projects will emphasize the development of a viable business plan for the production, adoption,

and distribution of the biocontrol products to ensure sustainability of efforts. Raising public awareness about aflatoxins and biocontrol and building the human capacity and support facilities of national partners will equally be given priority.

The aflatoxin control project in Kenya and Nigeria is funded by the Bill & Melinda Gates Foundation, USDA, and the African Agricultural Technology Foundation (AATF). We are working with the Ministries of Agriculture in Kenya and Nigeria, USDA-ARS, AATF, Kenya Agricultural Research Institute, Doreo Partners, the National Agency of Food and Drugs Administration and Control of Nigeria, and Commercial Agriculture Development Program.

The Zambia project, on the other hand, is funded through USAID-Zambia's Feed-the-Future Multi-Year Food Security Strategy Program. We are implementing it with the International Crops Research Institute for the Semi-Arid Tropics and in partnership with the Zambia Agriculture Research Institute, USDA-ARS, and the National Institute for Scientific and Industrial Research.

A woman farmer in NIgeria on her way to apply aflasafe in her maize field. Photo by R Bandyopadhyay, IITA.

The project in Senegal is funded by AATF and works with *Direction de la Protection des Végétaux*, *Université Gaston Berger*, St. Louis, and the USDA-ARS. The Burkina Faso project is funded by the Austrian Development Agency and involves the Institut de l'Environnement et de Recherches Agricoles, Vienna University of Technology, and USDA-ARS.

Field testing of aflasafe™ in Nigeria over the past four years has produced extremely positive results: aflatoxin contamination of maize and groundnut was consistently reduced by 80–90%, in some cases even as high as 99%. In 2011, we deployed nearly 14 tons of aflasafe™ in some 450 maize and groundnut farms.

Ranajit Bandyopadhyay, IITA Plant Pathologist, is optimistic that Kenya and Senegal will have their own versions of aflasafe™ within two years, Burkina Faso in three, and Zambia in four. He leads our work on aflatoxins together with Joseph Atehnkeng, Thomas Dubois, Charity Mutegi, and Titilayo Falade.

IITA staff preparing aflasafe for distribution to maize and groundnut farmers in northern Nigeria. Photo by R Bandyopdhyay, IITA.

Our work to develop aflasafe™ was

largely based on the successful aflatoxin research by Peter Cotty of the USDA-ARS.

This year, we worked with other institutions on advocacy that subsequently led to the establishment of the Partnership for Aflatoxin Control in Africa (PACA). The partnership was endorsed by the 7th Comprehensive Africa Agriculture Development Program's Partnership Platform, which underscored the urgent need to mitigate aflatoxin contamination in Africa. PACA has since been supported BMGF, USAID, UK Department for International Development, and other donors.

Our work on aflatoxin control and on establishing the partnership resulted in another grant titled "Expansion of biological control to manage aflatoxin in maize and groundnut using regionally-adapted beneficial fungi in Eastern and West Africa" from the Meridian Institute which manages a multi-donor fund on behalf of PACA.

The grant will be used to develop country-specific aflasafe™ for Ghana, Mali, and Tanzania, and regional biocontrol products for West, East, and Southern Africa.

The project will also design and construct a low-cost manufacturing facility in Nigeria to optimize and adapt the manufacturing process to a developing country context, as well as develop and test viable commercialization models of aflasafeTM in Nigeria. We will collaborate with USDA-ARS, Doreo Partners, and AATF in this effort.

Seeing yellow: tackling malnutrition with vitamin A cassava

In November, the Nigerian government officially released three new vitamin A-enriched 'yellow' cassava varieties that we developed with our partners that could deliver substantial quantities of the important nutrient in the diets of more than 70 million people.

The yellow color (cassava is generally white) of the newly released varieties is imparted by their high beta-carotene content, which the body converts to vitamin A when consumed.

Dr Akin Adesina, Nigeria's Minister of Agriculture (holding roots), publicly announcing the release of the vitamin A cassava varieties at NRCRI in Umudike, Abia State. Photo by O Olumide, IITA.

The release of the varieties is the culmination of our more than 20 years of intensive breeding efforts improve cassava's nutritional quality. The research was supported by funding from HarvestPlus and in partnership with Nigeria's National Root Crops Research Institute (NRCRI) and the International Center for Tropical Agriculture (known by its Spanish acronym CIAT).

The vitamin A cassava varieties, officially named by the National Variety Release Committee of Nigeria

as UMUCASS 36, UMUCASS 37, and UMUCASS 38, are recognized as IITA genotypes' IITA-TMS I011368, IITA-TMS I011412, and IITA-TMS I011371.

Vitamin A deficiency (VAD) is widely prevalent in sub-Saharan Africa. In Nigeria, VAD afflicts about 20 percent of pregnant women and 30 percent of children five years old and below. VAD can lower immunity and impair vision, and lead to blindness and even death. Yellow cassava provides a cost-effective medium to deliver vitamin A to VAD-vulnerable individuals and communities in Nigeria where the average person consumes about 600 grams of cassava in various forms daily.

Gari made from one of the newly released varieties, TMSI011371. Photo by JT Oliver, IITA.

Vitamin A is an anti-oxidant. Medical research has shown that regular vitamin A intake slows the progression of cataracts, promotes and maintains healthy vision, prevents muscular degeneration, boosts the immune system, regenerates healthy skin cells, and protects against an array of illnesses such as cancer, heart disease, asthma, depression, infertility, Parkinson's disease, psoriasis, arthritis, and high blood pressure.

The new varieties are envisioned to mostly benefit children and women, which could provide up to 25 percent of their daily vitamin A requirement.

Aside from being nutritious, the yellow varieties have also been proven to give high yields and offer good resistance to major diseases and pests. Farmers who evaluated them also said that the varieties are well suited for producing gari and other food products – they even swear that the yellow cassava tastes better than their white counterparts, too!

Farmers across the country, and even in other cassava producing countries in West Africa, are already clamoring for planting materials of these new varieties. HarvestPlus is working with IITA and local partners to multiply stem cuttings to satisfy the demand. By 2013, researchers say that there will be enough certified stems of the vitamin A cassava varieties to cover 25,000 households initially.

Cooking 'gari' from vitamin A-enriched yellow cassava, Cassava-based food products are important entry points to improve the health of people in Africa. Photo by O Adebayo, IITA.

By the mid-2014 harvest season, HarvestPlus and IITA expect that more than 150,000 farm household members will be eating vitamin A-enriched cassava.

Hot on the heels of this

breakthrough, we are already working on developing improved versions of these varieties that can provide up to 50 percent of the required daily vitamin A allowance. These further improved yellow cassava varieties should be ready in a few years.

Other collaborators in the development of the new vitamin A cassava include the Brazilian Agricultural Research Corporation (Embrapa) and various government and agricultural research and extension agencies in Nigeria.

Working a MIRACLE in Southern Africa

In sub-Saharan Africa, approximately 22.4 million people are living with HIV/AIDS. In rural areas where over 80 percent of the population depend on agriculture livelihoods, the disease presents a major challenge because it leads to reduced farm productivity due to shortage of labor, delays in farm operations, decline in livestock production, and loss of agricultural skills.

To address the challenges posed by HIV/AIDS on the

Getting the message across: MIRACLE employs role playing to raise awareness about HIV/AIDS in the target communities. Photo by JT Oliver, IITA.

A member of the women's group in one of MIRACLE's beneficiary communities explaining the benefits of some of the nutrient-dense dishes made from locally grown ingredients that the project will introduce. Photo by JT Oliver, IITA.

agricultural sector particularly in Southern Africa, IITA launched an initiative aimed at improving the productivity and helping ensure sustainable livelihoods of people living with HIV/AIDS (PLWHA) who are dependent on agriculture.

Dubbed "Making Agricultural Innovations Work for Smallholder Farmers Affected by HIV/AIDS in Southern Africa" – or MIRACLE – the three-year project aims to improve the overall health and nutrition status, food security, and incomes of small-scale farming households affected by HIV/AIDS through agriculture-related interventions. The project is funded by the Swedish International Development Cooperation Agency (SIDA).

IITA is implementing MIRACLE in four countries: Zambia, Swaziland, Malawi, and Mozambique and in partnership with various government agencies, NGOs, farmer groups, and community-based organizations.

MIRACLE's key interventions include production, consumption, and marketing of nutritious crop and livestock products, lobbying for supportive agricultural and health policies, and strengthening capacities of stakeholders.

As an approach, the project uses transfer of agricultural and postharvest innovations as a means of mitigating the impact of HIV/AIDS on affected smallholder farmers. Specifically, it promotes the production, value addition, and utilization at both small- and medium-scale commercial levels of nutrient-dense crop varieties that are also high-yielding, and resistant to drought, pests, and diseases. These crops include soybean, cowpea, quality protein maize, cassava, and sweetpotato, among others.

The project also encourages the production, marketing, and consumption of indigenous, yet nutritious, vegetables such as amaranths, pumpkin leaves, sweet potato leaves, cassava leaves, and other local and nutrient-packed vegetables. MIRACLE also pushes for the production of small livestock, focusing on feed formulation using dual or multipurpose legumes and cereals, improved animal housing, and better disease control particularly of chickens.

Beneficiary households are being trained to sustainably produce their own nutritious foods and to use these to generate additional incomes, and develop and promote value added products and processes from various nutrient-dense crops.

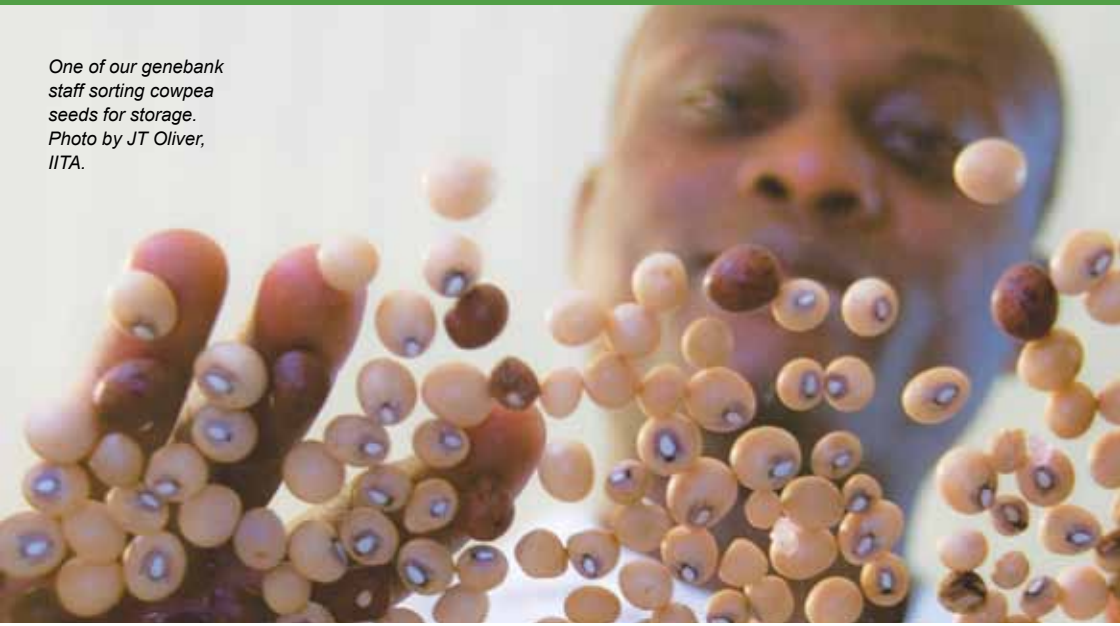
Soybean demonstration plot in Nkhata Bay MIRACLE site in Malawi. Photo by T Gondwe, IITA.

To ensure sustainability of its interventions, MIRACLE will advocate for appropriate national policies to link agriculture with nutrition and improve the general health status of PLWHA and their families in the project countries.

Aside from improving the socioeconomic and health conditions of HIV/AIDS-affected farming households, MIRACLE will also help ease the stigma associated with the disease.

More than half a century after the first case of HIV was diagnosed in the Congo in 1959, PLWHA still suffer discrimination especially in developing countries where education on the disease is almost non-existent. The UNAIDS in 2009 listed the HIV prevalence rate among adult population (15-49 years old) – the most labor-productive age group – in MIRACLE's target countries as 26.1 percent in Swaziland (the highest in southern Africa), 15.2 percent in Zambia, 12.5 percent in Mozambique, and 11.9 percent in Malawi.

Midseason evaluation of cowpea trials by women's group in Kazungula MIRACLE site in southern Zambia. Photo by T Gondwe, IITA.



One of our genebank staff sorting cowpea seeds for storage. Photo by JT Oliver, IITA.

Agrobiodiversity

Knowledge on the living and taxonomic collections of other (non-crop) organisms help researchers find sustainable ways to manage pests and diseases and improve soil fertility of ecosystems to enhance human welfare. We are involved in the conservation and sustainable use of biodiversity of fungi, plant associated microorganisms, insects, mites and parasitic nematodes for biological pest control and in the development of environment-friendly technologies to protect the natural habitat and conserve on-farm biodiversity.

The goal of our Agrobiodiversity Program is sustainable improvement in agricultural growth, particularly in sub-Saharan Africa, through increased use of efficiently conserved collections of important plant and non-plant biological resources.

Safeguarding Africa's precious crop biodiversity

As vanguard of Africa's crop biodiversity, we work to help stem the loss of the continent's plant genetic resources and optimize their potential by developing new and more effective ways to conserve and use them in crop improvement research.

Acquisition and distribution of crop genetic resources

Our Genetic Resources Center (GRC) holds more than 28,000 accessions of key food crops in sub-Saharan Africa and continuously work to expand our germplasm collection. We have also supported crop improvement and conservation activities of partners and other agricultural research organizations in various countries by providing them with the needed crop germplasm.

This year, the GRC acquired 289 accessions of various African crops, comprising of 10 new accessions of cocoyam from Ghana, 46 of cowpea from Sudan, 185 of yam from Benin, and 48 of yam from Costa Rica. We have also distributed germplasm to partner-requestors in Nigeria (African yam bean, bambara groundnut, cowpea, lab-lab beans, Lima bean, maize, pigeon

Genebank technicians arranging some of the in vitro *conserved yam germplasm in the GRC. Photo by JT Oliver, IITA.*

pea, soybean, sword bean, and yam); South Africa (bambara groundnut); India (bambara groundnut, cowpea, and soybean); Japan (cassava and yam); Fiji (cowpea); Senegal (cowpea); Zambia (cowpea); and the UK (wild *Vigna*).

Safety duplication of seed crop collections in the Svalbard Global Seed Vault

We hold the distinct honor of being the first international agricultural research center to send seeds to the Svalbard Global Seed Vault – also called the "Doomsday Vault" – located on the Norwegian island of Spitsbergen. Our initial consignment sent in January 2008 comprised of 7,000 unique seed samples of crops from 36 African nations. Between then and 2010, we have sent more than 12,000 accessions of African food crops to the seed vault, representing over 55 percent of our conserved seed germplasm.

GRC staff preparing seeds for shipment to the Svalbard Seed Vault. Photo by GRC.

In 2011, we sent an additional 2,017 germplasm accessions for safety duplication to the Svalbard Vault. This shipment comprises of 27 accessions of African yam bean, 317 of bambara groundnut, 1,577 of cowpea, and 96 of maize.

Cryopreservation of yam and cassava

During the year, researchers conducted experiments at the *Institut de recherche pour le développement* (IRD) in France and at IITA-Ibadan in Nigeria to compare two cryopreservation approaches developed for yam: encapsulation/dehydration by IRD and droplet/vitrification by IITA. Results showed that the droplet/vitrification approach was more suitable for yam cryopreservation. As the approach has also shown high efficiency for cassava, the approach will be used for the long-term preservation of the international collections of the two crops.

Long-term conservation of yam and cassava collections

Currently, the GRC maintains all accessions of yam and cassava in field bank conditions with a partial backup *in vitro*. Eventually, we plan to introduce and maintain these yam and cassava accessions under *in vitro* slow growth conditions.

Excising cassava material in preparation for in vitro *conservation. Photo by JT Oliver, IITA.*

Materials that qualify for cryopreservation – or conservation through deep-freeze – will be placed in cryobanks. Once an accession proves stable in *in vitro* slow growth

and is successfully duplicated in the cryobank, its field duplicate will be removed. For accessions that are stable *in vitro* but recalcitrant to cryopreservation, *in vitro* samples will be maintained at two different locations and the field duplicate will be eliminated.

Keeping track of what we have is an important function for the long-term conservation of our collection. Photo by JT Oliver, IITA.

We envision that with this approach, we will progressively reduce yam and cassava field banking activities in IITA-Ibadan; however, residual field activity will remain for *in vitro* recalcitrant accessions and field regeneration of the *in vitro*-stored samples (with true-to-type checking every five years).

It is proposed the *in vitro* slow growth and field activity in Ibadan be maintained, while the *in vitro* duplication and cryoprocessing/cryobanking activity be moved to our East Africa Hub in Dar es Salaam, Tanzania.

The transfer of the safety duplication activity to Tanzania will improve our standard on risk management of collections. It will also provide critical mass to the plant tissue culture activity planned for the Hub for eventual mass propagation and diffusion of clean germplasm in East and Southern Africa.

In the case of cassava, we will maintain botanical seeds of the core accessions in the long-term seed bank of the GRC with safety back-ups in genebanks in Saskatoon, Canada and Svalbard, Norway.

IITA Microbial Bioresource Collection

This year, researchers at our Germplasm Health Unit characterized and established a unique reference culture collection made up of bacteria, fungi, and viruses intercepted in germplasm, and of reference isolates of pathogens of sub-Saharan food and horticultural crops. The collection will serve as an important resource for research, verification of diversity, and development of diagnostic tools.

The collection, which was initiated in early this year, contains 68 fungal strains, 6 bacterial strains, and 8 virus species originated or intercepted in Nigeria that have been morphologically and biologically characterized.

This will be augmented by regularly adding new isolates and strains, including pathogens and beneficial agents. We are currently genetically characterizing (through DNA Barcoding) these isolates – based on rDNA, histone, beta-tublin, elongation factor or CO1 genes – to help eliminate redundant ones.

DNA isolated from these cultures is put in the DNA bank to also serve as reference standards in diagnostics.

CIALCA Conference 2011: putting humid tropics research in the global limelight

In October, over 200 farm researchers, development experts, and other stakeholders gathered in the Rwandan capital of Kigali for a landmark conference that took stock of agricultural development efforts in Central Africa's breadbasket and chart a path towards food security for the region.

The international conference is the first-ever that examined the challenges and opportunities for intensifying farm production of the humid tropics regions in sub-Saharan Africa. It was organized by the Consortium for Improving Agriculture-based Livelihoods in Central Africa (CIALCA), which we co-implement with Bioversity International and the Tropical Soil Biology and Fertility Institute of the International Center for Tropical Agriculture (TSBF-CIAT).

Participants of the CIALCA International Conference 2011 held in Kigali, Rwanda. Photo by JT Oliver, IITA.

(L-R) Jos Kalders, Hans Herren, Shem Martin Ndabikunze, Nteranya Sanginga, and a Rwanda official fielding questions from the media during the conference. Photo by JT Oliver, IITA.

The Great Lakes region, which includes Burundi, eastern Democratic Republic of the Congo, and Rwanda, has the highest population density in sub-Saharan Africa – up to 400 people per square kilometer in Rwanda and Burundi. Although these are high-potential areas for farm production due to good rainfall and temperatures that allow cropping most of the year, persistent civil conflicts, lack of infrastructure, political instability and poverty have left small farmers struggling to eke out a living. Food security is a major problem, with some areas reporting 30 to 40 percent of families going hungry.

Since 2006, CIALCA has been working with public and private sector partners to make improvements to farm production, market access, and child nutrition in the Great Lakes region.

Experts at the conference warned that countries in the Great Lakes region could face increased conflict and greater instability in coming decades unless there is widespread use of better farm approaches and innovations that could grow more food with less land.

"Previous conflicts have been indirectly driven by the ability of the land to support food needs of Central Africa's high population densities," said IITA Director General Nteranya Sanginga.

"In the future, the big question will be whether the land and the soils that underpin farm yields can support booming populations under new constraints like rapid climate change and other environmental factors," Sanginga told the conference, adding that food prices could continue to rise in the absence of sustainable intensification of food production.

"If we do not do anything now, we will be going back to the situation of war – a war not because of ethnicity but war for food, war for space," added Sanginga.

Indeed, the effects of climate change in the already resource-strained countries in the region are a major concern. For example, some of our recent studies have shown that the ability of farmers to grow coffee and banana – two of the region's largest cash crops – are severely affected by rising temperatures, making them more susceptible to pests and diseases.

Members of a women's group in Rwanda working on a communal maize-soybean farm. Photo by JT Oliver, IITA.

Hans Herren, president of the Millennium Institute and World Food Prize Laureate, said in a key note address that many farmers could not embrace new sustainable approaches to farm production as they could not access them. Besides, Herren added, some approaches were harmful to the environment.

Participants shared examples of sustainable farm approaches that could increase yields and alleviate land pressure in the region. They included the widespread adoption of higher-yielding climbing beans in Rwanda, and the availability of dietary protein and intercrop high-value coffee plants with banana in Uganda, Rwanda, and Burundi. The adoption of higher-yielding climbing beans is said to play a big role in improving soils.

Climbing beans growing alongside banana in a rural village in Rwanda. Photo by JT Oliver, IITA.

"Hopefully, it is these kinds of innovations that can help to steer the region towards a brighter future," said Jos Kalders of Belgium's Directorate General for Development Cooperation (DGDC) which funds CIALCA.

And while significant progress has been made in the region, scientists also drew attention to the

severe yield gap of sub-Saharan Africa's agricultural productivity. Staple crops such as maize, millet, beans, sweet potatoes, and cassava are being produced at 60 percent to 90 percent below their potential.

Participants at the conference reached consensus that agricultural research and development efforts should focus on sustainable intensification, which combines the most effective and sustainable approaches to improving farm yields.

At the close of the conference, Rwanda's Minister of Agriculture, Honorable Agnes Kalibata encouraged scientists present there to go beyond just helping farmers feed themselves.

Local women sorting maize in a village in Rwanda. Photo by JT Oliver, IITA.

"Aside from just producing food, it is also imperative that we help farmers connect to markets. Farmers will produce more if they are assured of markets," Kalibata emphasized.

"I also ask you not to keep your science on the shelves. Bring them to the fields and respond to the needs of farmers in real time. You have the power to improve the lives of African farmers, use it!" she concluded.

Banana and plantain is the fourth most important staple in sub-Saharan Africa. Photo by JT Oliver, IITA.

Banana and Plantain Systems

Grown by smallholder farmers, bananas and plantains are major staple food and leading cash crop in the tropics and sub-tropics. Bananas are similar in management to root and tuber crops, with clonal propagation and perishable, bulky harvested products. In the East African highlands, they are the top source of dietary calories, stabilize hillside soils against erosion, and are a main source of cash income for farmers.

We undertake research to increase the knowledge on ecosystems, social systems, and commodity chains related to banana and plantain production, improve the sustainability and profitability of banana and plantain systems, and improve the quality of banana- and plantain-based food products in Africa.

Maize to the rescue of African banana against an unseen enemy

Our banana and plantain researchers have found an unlikely ally in maize in the fight against nematodes– microscopic worms that damage the roots of plants, slowing their growth, making them prone to toppling, and producing smaller fruits.

In sub-Saharan Africa, smallholder growers lose 40 percent or more of their yields due to the tiny worms. Losses are so severe because bananas are grown on the same land which lets the worms build up a high density unlike the crop rotations methods practiced in Europe and the US.

A banana plant toppled over with roots showing damage from nematode infestation. Photo from ProMusa.

In experiments, our researchers infused maize cystatin gene and a synthetic nematode-repelling protein into the plantain, cv. *Gonja manjaya*. The cystatin introduced from maize kernel prevents nematodes from digesting proteins, literally "starving" them to death and greatly reducing their population. The nematode-repelling protein, on the other hand, makes the plantain's roots secrete a synthetic peptide that disables the nematodes' ability to find it.

Results of our tests showed that the maize cystatin and

peptide, alone or combined, can provide plantain with resistance to simultaneous infections by multiple nematode species, as what actually happens in the field. In the study, our scientists infused plantain with either one or both of the genes for single or dual nematode defense.

Feeding on the roots, nematodes restrict the flow of nutrients into the plants and stunt their growth. Farmers easily lose 40 percent or more of their crop because of nematode infestation, especially in areas frequented by storms and high winds. This is because nematodes damage and weaken the roots – the plant's anchor – causing the whole plant to completely topple over. Plants heavily laden with harvest-ready bunches are especially affected.

Our scientists worked with counterparts from the University of Leeds on the transgenic research in Uganda. The results of the study have been published in the latest edition of the journal Molecular Plant Pathology (http://onlinelibrary.wiley.com/doi/10.1111/j.1364-3703.2012.00792.x/abstract).

The research team assessed 245 independent transgenic lines (plantlets) for resistance to nematodes. From these, they identified the strongest 11 (those that showed more than 67 percent nematode resistance). These lines will be further evaluated in confined field trials in Uganda in collaboration with the National Agricultural Research Organization (NARO) after approval by the National Biosafety Authority.

Leena Tripathi, IITA Biotechnologist and one of the lead scientists, said that the research is a breakthrough in managing nematodes, which many

farmers are usually not aware of because they do their damage underground and are too small to be seen by the naked eye.

The team assures that maize cystatin is safe to use. It naturally occurs in the crop's kernel and has been in the diets of humans for as long as maize has been consumed. The safety of cystatin-based transgenic work has also been well-established in rice for years. A similar protein is present in human saliva.

Safety studies of the synthetic peptide also showed that it is destroyed by the high temperatures required for cooking plantain and by the digestive fluids in the intestine. In addition, the protein is not listed as being a potential allergen in *Allergenonline* and *Allmatch*, reference tools used by WHO and FAO.

While the safety of the genetic interventions has been proven in the laboratory and in many studies, we will still carry out further safety analyses during the field trials to ensure that they pose absolutely no danger to humans or the environment.

Nematode-resistant banana and plantain will help farmers to realize the crop's full economic potential. Photo by JT Oliver, IITA.

On the horizon: fully wilt disease-resistant banana

Good news for banana and plantain farmers across Africa: we have successfully developed and tested banana and plantain that are totally resistant to the deadly Banana *Xanthomonas* Wilt (BXW).

BXW causes crop production losses of more than US$500 million every year and puts at risk the food security and livelihoods of millions of mostly resource-poor smallholder farmers and their families. All banana varieties in Africa are vulnerable to the disease.

Leena Tripathi, lead scientist of our banana transformation research, says that 12 transgenic lines infused with wilt-resistance genes from green pepper had been shown to be 100 percent resistant to BXW under confined field trials in Uganda. The best 6-8 lines will be further tested in multi-location trials across the country.

BXW-resistant transgenic banana plants in the confined field trials in Uganda. Photo by L Tripathi, IITA.

We are also conducting environmental and food safety studies such as digestibility analyses to

ensure that they are not harmful to humans or animals in any way.

Local commercial varieties are extremely difficult to improve through conventional breeding because they do not produce seeds and are sterile, while it also takes about 15 years to produce an improved variety.

Banana bunches showing advanced and mid-stages of infection by BXW. Photo by P van Asten, IITA.

Given the rapid spread and devastation of BXW across the continent, genetic transformation through the use of modern biotechnology tools offers an effective, fast, safe, and viable way to develop resistant varieties.

However, she noted that more work needs to be done before open field trials could be conducted as Uganda does not currently have related laws that would allow such testing, but she is optimistic that the country would soon overcome this hurdle and, if all goes well, the world may see its first transgenic banana by 2017.

The wilt-resistance genes – plant ferredoxin-like amphipathic protein (*pflp*) and hypersensitive response-assisting protein (*hrap*) – were obtained under an agreement from Academia Sinica in Taiwan.

Aside from full resistance to BXW, the transformed lines also showed flowering and yield (bunch weight and fruit size) characteristics comparable to local non-transgenic varieties.

Partners in this research include the National Agricultural Research Organization (NARO) of Uganda and the African Agricultural Technology Foundation (AATF).

We are also working with the University of Leeds' Africa College in developing transgenic plantain that is resistant to nematodes (see preceding article "Maize to the rescue of African banana against an invisible enemy").

The plants have shown promising results in screenhouse trials and the best lines will soon be planted in confined field trials also in Uganda.

Tripathi added that the institute will also look at stacking the anti-wilt genes with anti-nematode genes in the same plant for multiple resistance.

"One, please!" Banana and plantain that are fully resistant to BXW will enable farmers to recover more than US$500 million in lost food and income potential. Photo by O Adebayo, IITA.

Women making their way to the market with their cowpea produce. Photo by S Muranaka, IITA.

Cereals and Legumes Systems

Cereals and legumes such as maize, soybean, and cowpea are important food, feed, and cash crops mainly grown by smallscale farmers in sub-Saharan Africa.

However, the productivity of these cereal and legume crops is currently low due to pests and diseases, poor soil fertility, poor access to improved seeds and postharvest technologies, inadequate research and extension capacity, underdeveloped markets, and policy and institutional constraints.

Through our Cereal and Legume Systems Program, we aim to generate research products and services that increase the productivity and commercialization of cereal and legume systems while preserving the natural resource base.

Pushing back against the violet vampire

Together with our partners in Nigeria and Kenya, we have begun a major push against parasitic weed that have spread across much of sub-Saharan Africa, wreaking havoc of up to US$ 1.2 billion in damage every year to the maize and cowpea crops of tens of millions of smallholder farmers.

Through a project, we are introducing proven technologies for fighting *Striga* – also called "witchweed" – and *Alectra*. Also known as the "violet vampire" because of the bright purple flower it produces, *Striga* attaches itself to the roots of crops such as maize and cowpea, sucking out nutrients, reducing yields, and destroying entire harvests.

Witchweed primarily affects smallholder farmers who can't afford costly herbicides for fighting the parasitic plant. The most widespread *Striga* species is estimated to infest up to 4 million hectares of land under maize in sub-Saharan Africa, causing yield losses of up to 80 percent and affecting approximately 100 million people in the region.

A maize field in northern Nigeria heavily infested with Striga. *Photo by S Muranaka, IITA.*

The US$ 9.0 million *Striga* project is

supported by a US$ 6.75 million grant from the Bill & Melinda Gates Foundation to IITA. Its goal is to help 200,000 maize farmers and 50,000 cowpea farmers in areas with high rates of *Striga* infestation in Kenya and Nigeria. By project's end in 2014, we estimate that over 250,000 individual farmers will see up to 50% higher maize yields and double their current cowpea yields.

Less Striga *means more maize; more maize means more income and better livelihoods for smallholder farmers. Photo by J Atehnkeng, IITA.*

The four-year project will focus on improving and expanding access to methods of *Striga* control, while supporting research to identify the most effective means of controlling the parasitic weed under varying conditions. It will evaluate and implement four approaches: using *Striga*-resistant crop varieties; using a "push-pull" technology that involves intercropping with specific forage legumes that inhibit the germination of *Striga*; using herbicide-coated seeds; and deploying biocontrol of *Striga*. After a two-year evaluation period, the project will scale up the most effective approaches.

Each of the approaches to control *Striga* holds promise, especially when two or more options are employed at the same time. For example, in West

Africa, we have tested the combined use of *Striga*-resistant maize varieties in rotation with legumes that cause witchweed seeds to germinate but fail to latch on to the host. This approach increased crop productivity by an average of 88 percent.

We will partner in this initiative with the International Maize and Wheat Improvement Center (CIMMYT), African Agricultural Technology Foundation (AATF), International Centre of Insect Physiology and Ecology (icipe), and BASF Crop Protection.

We expect that the integrated witchweed control interventions will generate an estimated US$8.6 million worth of additional grain (maize and legumes) annually at the project locations—resulting in increased incomes, better nutrition, and reduced poverty, as well as employment opportunities from grain production to food markets.

New maize and soybean varieties hold promise for African farmers

Smallholder farmers in Malawi and Nigeria are celebrating the release of new soybean and maize varieties that are offering hope of better incomes and livelihoods.

New soybean in Malawi

The Malawi Agricultural Technology Clearing Committee (ATCC) in January 2011 officially approved the release of the improved variety dubbed TGx1740-2F. We developed the variety through our

Tropical Legumes II project.

In on-station and on-farm trials, TGx1740-2F outperformed local varieties grown in the country, giving a mean grain yield of 2,464 kg/ha. Pre-release production data showed that the new variety exceeded the yields of the varieties Nasoko and the widely grown promiscuous variety Magoye, which were used as checks, by 10% and 32%, respectively, during the two-year multilocation station trials.

A Malawi soybean farmer tending to her young crop. Photo by JT Oliver, IITA.

TGx1740-2F performed equally well during on-farm participatory variety selection trials in four districts of central Malawi. In the 2009/10 season, it outperformed all the new types of soybean varieties under testing, giving 2,248 kg of grains per hectare. Again, it also surpassed yields by Nasoko and Magoye by 15% and 38%, respectively.

This new variety matures early, has more pods per plant up to the top of the plant, performs well under poor and erratic rainfall, and has better lodging resistance.

The release of TGx1740-2F is considered a milestone for IITA as this is the first time that a promiscuous soybean variety – one that is able to nodulate effectively with diverse indigenous Rhizobia in the soil – developed by the institute has been released in Malawi.

Quality protein and drought-tolerant maize varieties in Nigeria

Maize production in Nigeria got a much needed boost as the national government approved the release of five new maize varieties. In addition to having high nutritive content and tolerance to drought, the new varieties also offer good resistance to diseases and pests such as parasitic weeds and maize streak, mature early, and give high yields.

Drying maize. The newly released varieties offer new hope for farmers and processors in Nigeria. Photo by JT Oliver, IITA.

In December 2011, the Nigeria Variety Release Committee officially approved the release of SAMMAZ 32, SAMMAZ 33, SAMMAZ 34, SAMMAZ 35, and SAMMAZ 37. The first four varieties are extra early-maturing varieties, while SAMMAZ 37 is an intermediate-maturing quality

protein maize (QPM) variety. The varieties were developed by the Institute for Agricultural Research at Samaru in collaboration with our breeders. They are products of conventional breeding that incorporated high-lysine gene into adapted populations of selected lines.

SAMMAZ 32, SAMMAZ 33, SAMMAZ 34, and SAMMAZ 35 have good levels of resistance to Striga hermonthica and maize streak virus, high tryptophan content, mature in 80 to 85 days, and have yield potentials of 3.5 to 4.5 tons per hectare.

SAMMAZ 37, on the other hand, is a yellow endosperm variety that matures in 115 days, has good resistance to the maize streak virus, high tryptophan content, and a potential yield of 5.9 tons per hectare.

Drought-tolerant maize critical to food production in West Africa – Study

A research study has proven what most people have always known but are not saying out loud: access to improved seeds by smallholder farmers is a vital prerequisite to significantly increase maize production in West Africa in light of climate change and floundering yields of traditional varieties.

The study was conducted by researchers working on the Drought Tolerant Maize for Africa Project (DTMA) implemented by the International Maize and Wheat Improvement Center (known by its Spanish acronym CIMMYT) and IITA.

Tahirou Abdoulaye, IITA Impact Socioeconomist and lead researcher of the study team, notes that

A farmer-participant of the DTMA project inspecting a cob harvested from his farm planted to drought-tolerant maize. Photo by T Abdoulaye, IITA.

improved maize varieties tolerant of drought are helping farmers in addressing production risks and called for joint efforts to facilitate their wider dissemination across sub-Saharan Africa (SSA).

The DTMA Project is helping farmers in cushioning the negative effect of drought by developing and disseminating maize with significantly improved drought tolerance.

The study also highlighted the importance of seed companies in the dissemination of quality seeds. It found that although the number of seed companies in West Africa has more than doubled since 2007 – from about 10 established companies to more than 22 currently in the four DTMA participating West African countries of Nigeria, Benin, Mali, and Ghana – their combined production is still below demand.

For instance, the total production of improved maize seeds in those countries stands at about less than 15,000 metric tons while more than 80,000 metric tons are required for Nigeria alone.

Based on the findings of the study, Abdoulaye is urging governments in the region to tackle the

challenge of poor irrigation to pave the way for year-round production of improved seeds to accelerate availability and meet demand.

While he commended member countries for adopting fairly liberal seed laws, Abdoulaye advised that the Economic Community of West African States must step up efforts that would see the full implementation of the harmonized regional seed law.

"This will help countries that are lagging behind, as improved drought-tolerant maize varieties will move freely across the region," he says. "It is equally important for governments in the region to help seed companies gain access to working capital," Abdoulaye added.

Consumed by more than 650 million people in SSA, maize productivity in recent years has been severely threatened by frequent droughts and irregular rainfall. In 2011 alone, more than 12.5 million people suffered the effects of drought – the worst in 60 years – and resulting famines in the Horn of Africa. In West and Central Africa, more than 35 percent of the area under maize is affected by drought as nearly the entire crop is grown without irrigation, relying solely on precipitation.

A woman farmer gathering some of her drought-tolerant maize harvest. Photo by J Atehnkeng, IITA.

Horticulture and Tree Systems

Fruits, vegetables, and tree crops present an ideal opportunity for poor African farmers to derive additional income through crop diversification, which results in better use of available land, water and labor resources. However, the potential of these crops cannot be realized fully because African farmers face a wide range of constraints.

Through our Horticulture and Tree Systems Program, we aim to to improve the productivity of fruits, vegetable, and tree crops by diversifying the existing staple cropping systems to give resource-poor farmers an opportunity to generate more income from exports and value addition. These crops also provide food and nutritional security for producers and consumers.

The legacy of the Sustainable Tree Crops Program

This year, our Sustainable Tree Crops Program (STCP) came to an official close after two phases and almost 10 years of helping cocoa farmers in West and Central Africa.

We established STCP in November 2002 in response to the growing challenges in the tree crops sector, particularly of cocoa, cashew, and coffee, in the region. The program was supported by the United States Agency for International Development (USAID) and the World Cocoa Foundation (WCF) and its global chocolate industry members.

STCP was a public-private partnership and an innovation platform that enhanced productivity through innovations, increased marketing efficiency, diversified farmer income, and strengthened the institutional and policy environment.

STCP began as a three-year pilot program covering Cameroon, Cote d'Ivoire, Ghana, Guinea, and Nigeria. Following the successful completion of the pilot phase, we launched STCP Phase 2 in 2007 at the recommendation of an external review committee and expanding its scope to include marketing, production, and institutional innovations. Liberia was brought on board replacing Guinea.

Since its inception, STCP has worked to bring cocoa back into the global development spotlight. The following summarizes the highlights of the program's achievements during its second phase from 2007 to 2011.

Building capacities, enriching lives

By the end of its Phase 2 run, STCP has trained more than 100,000 farmers, extension workers, and facilitators in the five participating countries in integrated crop and pest management and quality (ICPM/Q), planting, replanting and diversification (PRD), and occupational health and safety (OHS). STCP carried out training through its innovative Farmer Field Schools (FFS)/ Farmer Learning Groups (FLG) and Video Viewing Clubs (VVC).

Training in selected communities were handled by facilitators identified from the same community and working with STCP participatory extension specialists (PES) and cocoa subject matter specialists.

A woman community facilitator leads discussions in the cocoa extension manual during a VVC session. Photo by Ambrose Dziwornu, IITA-STCP.

To significantly multiply its capacity building impact, STCP introduced an innovation called farmer-to-farmer diffusion, in which farmers directly trained by STCP were required to train two other farmers on topics that they learned. This arrangement was formalized in knowledge-sharing agreement signed by each direct trainee prior to training.

STCP supported each direct and indirect trainee with training and extension materials. The highly illustrated manuals were used during and after the training to reinforce learning and adoption of skills among the farmer-participants.

An FFS session in progress with a farmer doing a presentation Photo by Ambrose Dziwornu, IITA-STCP.

To follow up on its training activities, STCP held field days for primary and secondary knowledge recipients of FFS, during which PES conducted short refresher courses on various cocoa-production topics.

STCP tracked data about its training activities through a monitoring and evaluation (M&E) database. Related information can be easily retrieved from the database for impact analysis.

Aside from cocoa farmers, STCP also trained staff of industry partners and government agricultural extension agencies, and provided technical support and backstopping for their own training activities.

Innovating for development

During its run, STCP initiated innovative approaches and platforms in West and Central Africa aimed at making cocoa extension more effective and responsive to the needs of farmers in the subregion.

Farmer-to-Farmer Diffusion

In West and Central Africa where cocoa farmers outnumber available extension resources, STCP introduced farmer-to-farmer diffusion to bridge the extension gap. In this approach, farmers directly trained by STCP were required to train two other farmers on cocoa production in return for the training they received.

Video Viewing Clubs

To address the perceived male dominance of the cocoa sectors in the participating countries, STCP established VVCs geared specifically to deliver extension and training on cocoa production to women farmers. Although originally conceptualized to cater to women, and largely because of the approach's effectiveness, male farmers were eventually allowed to join VVCs, but priority has always been given to women. By the end of STCP Phase 2, VVC has benefitted more than 10,300 female and male farmers, extension workers, and facilitators. An impact

A Video Viewing Club in session in Ghana. Photo by IITA.

evaluation of the VVC also showed that farmers who participated in the approach were likely to increase their yields by as much as 40 percent.

Each enrolled farmer attended an average of 20 VVC sessions to complete training, with video viewing interspersed with practical field exercises to enforce learning. For the VVCs, STCP developed 11 technical videos on cocoa ICPM/Q. These videos are accessible from the Web.

In 2008, the VVC approach was conferred the CGIAR Science Awards for Outstanding Communications, citing STCP "for training farmers in West African countries use digital video as a way to share knowledge of sustainable cocoa production."

Plant Material Brokerage System

Through this approach, STCP assisted its trained farmers in procuring hybrid cocoa pods and seedlings for establishing nurseries or for direct planting on their fields, and in obtaining tree seeds/ seedlings that were integrated into old and new farms.

A hybrid cocoa nursery in Cameroon. The hybrid cocoa seeds used in the establishment of the nursery were supplied by STCP. Photo by IITA-STCP.

During its second phase, STCP distributed

about 15.53 million cocoa seedlings and more than 600,000 cocoa pods. In addition to cocoa planting materials, STCP also distributed cassava stems to cocoa farmers which were grown and used as temporary shade for cocoa stands and as food crop.

The program also established two Cocoa Production System Planting Material Resource Centers in Ghana. Conceived under the Cocoa Sector Support Program (CSSP) Phase II - a bilateral project of STCP- the centers served as the first of its kind one-stop source points for cocoa planting materials and other crops used in cocoa production systems. The centers also offer extension and training services for cocoa farmers through technical videos.

Jim Gockowski of IITA-STCP (third from left) sat as a panel member at the UN's Climate Change Conference in Poznan, Poland. During the conference he also presented some of STCP's research related to climate change.

Research at the core, research for the common good

STCP's research studies and findings are treated as global public goods and therefore could be freely accessed, used, and shared with stakeholders and partners. These findings and results have been presented in numerous international conferences

and seminars by IITA and STCP staff and could be accessed from the IITA (www.iita.org) and STCP (http://liferay.iita.org/web/stcp/home) Web sites. Throughout its second phase, STCP produced and disseminated 13 journal articles, 13 working papers, 25 training manuals, 2 policy briefs, 1 impact brief, and a number of newsletters, technical articles, and press releases. The program also conducted about 20 scientific studies and impact assessments.

Hand-in-hand with partners for impact

STCP Phase 2 simultaneously operated with existing bilateral projects of partners within its operational countries. These included, among others, the Cocoa Livelihoods Program (CLP) sponsored by the World Cocoa Foundation (WCF); CSSP funded by the European Union; and the Mars Partnership for African Cocoa Communities of Tomorrow (iMPACT) funded by Mars Chocolate, Inc. Working with these partners and complementing existing similar projects significantly boosted STCP's own impact.

The international development broker

In 2011, STCP, working with the Ghana Cocoa Board, facilitated the development and finalization of an agreement between the governments of Ghana and the Republic of Liberia to jointly develop, promote, and implement research activities to improve their respective agricultural sectors. The agreement was officially sealed with the signing of a Memorandum of Understanding by high-level officials of the two countries during the early part of the year.

A project collaborator gathering yield data on quality protein maize in Swaziland. Photo by T Gondwe, IITA.

Opportunities and Threats

Smallholder producers in the developing world operate under ever-changing conditions of growing food demand, increasing resource scarcity, pressure from biological threats, tighter competition for land and water, and changing climate.

Through our Opportunities and Threats Program, we provide reconnaissance and strategic analysis on drivers of changes to African agriculture for improved targeting and impact of our R4D initiatives. Specifically, we aim to increase knowledge about ecosystems, social systems, and commodity chains; and increase research effectiveness, efficiency, and relevance to address current and future challenges.

Helping smallholder farmers in Africa adapt to an evolving agricultural landscape

This year, we continued with initiatives that help smallholder farmers and other stakeholders cope to an ever-changing agricultural landscape by providing science-based knowledge, assessing the environment, and documenting impact to support scaling-up of effective interventions.

Managing and disseminating information on African crops

In 2011, we made significant progress toward setting up the online AgriSTAT database of the African food crops that we work on. With the database's user interface now completed, specific datasets can be queried and retrieved in standard MS Excel format. We are now focusing on uploading and editing time-series and cross-sectional data on crop production, harvested area, and yield per hectare; prices of crops and crop products; modern or improved varieties of our core research crops; rainfall data; and various development indicators.

We also developed and disseminated a two-report series on cowpeas and yams entitled "World Cowpea Economy: Facts, Trends, and Outlook" and "World Yam Economy: Facts, Trends, and Outlook", as well as another document focusing on legumes titled "Tropical Legumes in Africa and South Asia: Trends, Outlook, and Opportunities". The reports paint a regional and global picture of the economics

of cowpea, yam, and legumes and provide up-to-date information for stakeholders engaged in the production, processing, and marketing of the crops to help them make informed investment decisions.

Assessing the agricultural landscape

We conducted rapid value chain assessment surveys in the eight countries participating in the "Putting Nitrogen Fixation to Work for Smallholder Farmers in Africa" project that we are implementing. These include the Democratic Republic of the Congo (South Kivu), Ghana, Kenya, Malawi, Mozambique, Nigeria, Rwanda, and Zimbabwe. The surveys evaluated local, national, and global forces that are driving changes in grain legume systems such as common beans, cowpeas, groundnuts, and soybeans in these countries. The aim is to identify opportunities and constraints for grain legume-based economic growth, so that research areas can be prioritized and resources allocated to areas that will give the most return on investment.

A project participant helping gather groundnut samples for yield analysis. Photo by J Atehnkeng, IITA.

We also carried out surveys to identify replicable and profitable cassava processing business models in Tanzania. The surveys, conducted between March and April 2011, involved 125 households and small-scale cassava processing businesses in the Coast and Mtwara Regions of Tanzania and assessed the determinants of scale, technical, operational efficiency and profitability of cassava processing enterprises, and replicability of the applied business model. The results of the surveys are being analyzed and will be finalized early next year.

Some of our publications documenting the impact of our work in sub-Saharan Africa and beyond.

Documenting the impact of our work

During the year, we produced several papers and information materials that documented the impact of our research efforts across sub-Saharan Africa. These include the publication of an article on the impact of our "Promoting Sustainable Agriculture in Borno" project on the adoption of improved crop varieties in northern Nigeria in the peer-reviewed Journal of Food, Agriculture, and Environment; production of the September edition of the R4D Review series that focused on our work in the social sciences; publication of the proceedings entitled "Outcome and Impact Assessment at IITA: Issues and

Evidence"; production of the "IITA Social Science Research Agenda for the Next Decade"; and the completion of the PhD thesis by Djana Mignouna on the adoption and impact of IR-Maize in western Kenya.

We also completed a survey of the adoption and socioeconomic impact of cassava integrated pest management technologies in Cameroon involving 320 respondents from the four regions of the country. Results of this survey are being compared with similar surveys conducted in Central and Northern Benin. Initial analysis of the comparative data showed remarkable gender-based differentiation of cultivation and transformation strategies by country and region. Additionally, respondents in all the countries surveyed identified the lack of a formal network for the distribution of pest-resistant varieties as a common problem. We conducted a similar study on CIALCA technologies in Rwanda, Burundi, and Eastern DRC, the results of which are still being compiled and analyzed.

A farmer spraying pesticide on his vegetable crop. We conducted surveys in Benin and Cameroon to determine the socioeconomic impact of IPM on smallholder growers. Photo by Arnstein Staverloekk.

Former President Obasanjo named IITA Goodwill Ambassador

Former President Olusegun Obasanjo has accepted IITA's offer to be the institute's 'Goodwill Ambassador,' in an effort to strengthen the fight against hunger and poverty in Africa. Director General Nteranya Sanginga announced Obasanjo's acceptance of the role in November.

As Goodwill Ambassador, Obasanjo will help the institute in advocating for policies that would advance agricultural research and bring to reality the long-awaited African Green Revolution. He will extend and amplify the institute's vision and mission and help focus the world's attention on our R4D work in sub-Saharan Africa and, to some extent, other countries in the humid tropics. Obasanjo's role as Goodwill Ambassador is envisioned to boost

Obasanjo (2nd from left) with Sanginga after the former president's acceptance of the role of IITA Ambassador. Photo by C Ono Raphael, IITA.

our thrusts to improve the plight of some 20 million resource-poor smallholder farmers and assist in reviving 25 million hectares of degraded agricultural lands in the next 10 years.

Born in March 1937, Obasanjo was the first Nigerian President to hand over to a democratically elected president - first as a military head of state in 1979, and second in 2007 as a civilian president. Under his watch, the country's growth rate doubled, its foreign reserves rose from US$2 billion to US$43 billion, and the nation became debt-free. In 2005, the international community gave the Nigerian government its first passing mark for its anti-corruption efforts.

In the agricultural sector, Obasanjo initiated the Presidential Initiatives on some of Nigeria's major commodities including cassava, maize, rice, and cocoa. His 10 percent cassava policy that mandated flour millers to include cassava flour in wheat boosted cassava production by 10 million tons between 2002 and 2008.

As a result, Nigeria became the world's number one producer of cassava, while maize became a major cash and economic crop. Maize, rice, and cocoa yields in Nigeria also recorded substantial increases during Obasanjo's tenure.

A young cassava farmer bringing home some of his newly harvested roots. Photo by JT Oliver, IITA.

Roots and Tubers System

Root and tuber crops such as cassava, yam, and cocoyam are major staples in large parts of humid and subhumid sub-Saharan Africa and are largely produced by smallholders who rely on traditional, labor-intensive practices. Cassava provides affordable food for urban populations and raw material for industries. Yam is a traditional African tuber crop with high consumer preference and is also a major source of income. While these crops have high agronomic and economic potentials, they are facing increasing production and postharvest challenges.

Through our Roots and Tubers System, we conduct research to increase the productivity of root and tuber crops, add value and expand markets, reduce producer and consumer risks, advocate policy reforms, and document impact.

Yam farmers need not be poor: US$12 million landmark initiative to boost yam productivity in West Africa

In one of the most ambitious efforts ever undertaken on behalf of a smallholder crop like yam, IITA and a host of partners have embarked on a groundbreaking initiative to dramatically boost yam productivity and double the incomes of more than three million farmers in West Africa.

The five-year "Yam Improvement for Income and Food Security in West Africa" (YIIFSWA) project, which is supported by a US$12 million grant from the Bill & Melinda Gates Foundation, is being led by IITA in collaboration with the National Root Crops Research Institute (NRCRI) of Nigeria, the Crops Research Institute (CRI) of Ghana, the UK's Natural Resources Institute (NRI), the Alliance for a Green Revolution in Africa (AGRA), and Catholic Relief Services (CRS). The YIIFSWA project focuses on increasing yam yields through better seed

A yam market in Nigeria. Yams are a vital source of livelihoods for millions of people in West Africa. Photo by H Kikuno, IITA.

tuber supply and improving markets.

Yams provide the most important source of dietary calories in Nigeria and Ghana. And for many people in the region, they rank above meat as the main source of protein. Despite its food and economic potentials, the fate of yams hangs in the balance as a variety of factors have depressed yields to a mere 14 percent of potential harvests. But with additional investments, there is tremendous potential to rapidly boost yam production and the income derived from the crop.

A typical structure for keeping seed yams in northern Nigeria. YIIFSWA will ensure that affordable and clean seed yams are available to farmers. Photo by H Kikuno, IITA.

YIIFSWA will initially focus on 200,000 smallholder farm families in Ghana and Nigeria—90 percent of whom cultivate less than two hectares. A key priority is to ensure that affordable pest- and disease-free seed yams are available to farmers, along with storage and handling technologies that can reduce post-harvest loss. Yam breeders will develop and widely disseminate new, higher-yielding, disease-resistant varieties. The private sector partners will provide certified seed and help link smallholder farmers, particularly those in remote areas,

A woman trader arranging yam tubers in a truck for transport to markets. Photo by H Kikuno, IITA.

to markets where a strong and steady demand for yams should allow them to realize the economic benefits of increased productivity. This will be coordinated by AGRA's Farmer Organization Support Centre in Africa (FOSCA) program.

Yam cultivation remains a lucrative enterprise in Nigeria. With a potential rate of return of 78 percent, each dollar invested in yam research generates US$52 worth of additional food for the poor, relative to US$124 for all households. Additionally, creating an abundance of a locally produced nutritious staple like yams can provide insurance against crises sparked by a sudden, sharp rise in global food prices.

A key goal of the YIIFSWA project is to improve not just yield and outputs in the field but also to enhance market access for smallholder farmers. Although smallholder farmers cultivate the majority of yams in the region, our findings show that those benefiting from the domestic, regional and global market for yams are mainly medium to large-scale producers. A combination of higher yields in the fields, reduced production costs through improved

seed tuber supply, and better market access for smallholder growers will not only improve incomes for farmers, but also increase the affordability and consumption of yams in both rural and urban areas.

Yams stored and marked ready for processing. Photo by H Kikuno, IITA.

Work by the UK's Department for International Development (DFID) - a long-time partner to IITA's yam research - has shown that there is a significant potential for YIIFSWA to attract private sector investment in the production of certified yam seed that are clean, healthy, available and much more affordable.

For example, in different parts of Nigeria, anywhere from 66 to 97 percent of households desire to eat yams on a weekly basis. Yet the domestic price of yams is well above the reach of many such consumers, whose low income make them only able to afford to buy slices rather than whole tubers. In addition, there are lucrative export opportunities to meet the demand of West Africans living abroad. In 2011 alone, Nigeria exported some US$27.7 million worth of yams to the USA.

IITA cassava bread influences Nigeria cassava utilization policy

His Excellency President Goodluck Jonathan of Nigeria has hinted that the country may soon have a new policy on bread content, following our successful development of bread that contains 40 percent cassava flour.

Jonathan emphasized that achieving 40 percent cassava flour content in bread was indeed a major breakthrough. According to the Nigerian president, using 40 percent cassava flour to replace wheat flour in bread will save the country more than US$ 2 billion per year in wheat import payments, which could otherwise go towards improving the livelihoods of millions of Nigerian cassava farmers and their families.

The president directed his ministers to come up with policies to encourage the increased use of cassava flour in the production of bread in the country after presenting the IITA-developed cassava

Nigerian President Goodluck Jonathan promoting IITA-developed cassava bread on national TV during the Federal Executive Council meeting in Abuja in November 2011. Video grab from NTA News.

bread to the nation at a meeting of the Federal Executive Council (FEC) in Abuja in November 2011 that was televised across the nation.

"I thought it proper for us in the FEC to formally present this bread to the nation; we owe it to the people."

Jonathan told the Ministers of Economy, National Planning, Trade and Investment, and Agriculture, and his Chief Economic Adviser to put their heads together and submit to him policies that the Nigerian government could implement to encourage those who use cassava flour for their manufacturing processes.

Agriculture Minister Adesina (2nd from right) with IITA DG Sanginga (3rd from right) and other staff during the minister's visit to IITA-Ibadan to see the production of the cassava bread. Photo by O Adebayo, IITA.

"For us as a nation to move forward, we need to tame our taste for exotic products. Some of the things we bring from outside are not even as good as what we have right here in our country," the president emphasized as he lauded the product.

Jonathan said that after he sampled the IITA-developed bread, he told himself that it will be the only bread that he would eat from now on.

The president explained that efforts to incorporate cassava flour in bread was initiated by the administration of former President Olusegun Obasanjo, who decreed that bakers put in at least

10 percent cassava flour in the breads they make, largely because of the rising cost of wheat in the international market.

Akinwumi Adesina, Nigeria's Minister of Agriculture and Rural Development said that the IITA-developed cassava bread "will create a lot of jobs, spur markets for our farmers, stabilize prices, and give us pride in the fact that we eat what we produce".

He added that the IITA initiative fits perfectly within the government's Agriculture Transformation Agenda aimed at developing the agricultural sector and increasing its share to the country's GDP.

The minister also noted that although Nigeria was the world's top producer of cassava roots, producing 34 million tons annually, the country accounted for zero percent in terms of added value which is unfortunate given the vast potential of the root crop.

Mounds of cassava flour for sale in a rural market. An expanded national policy on the use of cassava flour in bread will further spur the development of the cassava sector. Photo by O Adebayo, IITA.

Bactrocera invadens, *fruit flies that infest locally grown fruits. One of our new IPM projects aims to control these pests. Photo by SP-IPM.*

Integrated Pest Management (CGIAR Systemwide Program)

The CGIAR Systemwide Program on Integrated Pest Management (SP-IPM) is a global partnership program that aims to: (1) tackle those areas where research promises to provide solutions to pressing problems in sustainable agricultural development but where impact has so far been limited, usually due to fragmentation of efforts or inadequate links between researchers and farmers; (2) address new challenges posed by the fast growing demand for safe and affordable food under difficult circumstances caused by climate change and variability; (3) draw together the IPM efforts of the international agricultural research centers and their partners and to focus these efforts more clearly on the needs of

resource-poor farmers in the developing world; and (4) comparatively analyze different institutional experiences that will result in common lessons, methods, tools and services to guide collective action.

SP-IPM: heeding the call for global plant health management

This year, the SP-IPM program that we coordinate participated in high profile events that raised awareness on the importance of integrated pest management, as well as successfully lobbied for new projects that will help smallholder growers in sub-Saharan Africa battle pests and diseases that hinder production.

SP-IPM at the XVII International Plant Protection Congress

Every four years, the International Association for Plant Protection Sciences (IAPPS) organizes the International Plant Protection Congress (IPPC), an event in which SP-IPM showcases its achievements in collaborative crop health management research undertaken by its member centers. In 2011, the XVII IPPC was held in cooperation with the American Phytopathological Society (APS) in Honolulu, Hawaii from 6 to 10 August. The SP-IPM Coordinator actively participated in the preparations for the event as a member of the organizing committee at the request of IAPPS.

SP-IPM Special Session

During the XVII IPPC, the SP-IPM Secretariat held a special session themed "Crop Health Management for Food Safety and Agroecosystem Health in Developing Countries" on 10 August.

The symposium highlighted the need for a paradigm shift – from looking at crop production, plant breeding, and soil fertility research as separate entities to treating them as one under crop health management. This integrated approach combines the contributions of IPM, plant breeding, and soil fertility to improve crop and human health and enhance agroecosystem resilience to pests and diseases.

SP-IPM Coordinator Irmgard Hoeschle-Zeledon (seated) chairing the SP-IPM session at the XVII IPPC. Photo by SP-IPM.

SP-IPM members also discussed new IPM approaches to assist farmers in least developed countries to manage mycotoxins and keep pesticide residues below the acceptable levels set by international trade regulations based on health concerns.

The approaches, contained in seven presentations, addressed the negative effects of the production of unsafe foods on human and livestock health,

economic development, and trade opportunities. The presentations are available from the SP-IPM Web site at www.spipm.cgiar.org.

The highly successful and well-attended SP-IPM special session was also one of the few symposia during the congress that had a clear focus on plant protection issues in developing countries. The symposium was moderated by Richard Sikora, Chair of SP-IPM.

IPM Workshop for the Feed-the-Future Initiative

At the same event, SP-IPM, together with the IAPPS Secretariat and the IPM Collaborative Research Support Program on IPM (IPM-CRSP), organized a workshop on "IPM for the Feed-the-Future Initiative" that reviewed the plant protection activities of different international agencies as well as chart the way forward in this area.

The workshop produced a nine-point agenda to enhance the impact of the Feed-the-Future (FTF) initiative, which are also are applicable in similar agricultural programs funded by international donor agencies worldwide. These recommendations can be downloaded from the SP-IPM Web site.

A presentation during the IPM Workshop for USAID's Feed-the-Future Initiative at the XVII IPPC. Photo by SP-IPM.

SP-IPM staff meeting

During the congress, the SP-IPM Secretariat held a program meeting to take advantage of the attendance of SP-IPM staff at the event and in lieu of a Steering Committee meeting for the year. Participants extensively reviewed the achievements of the program for the past three years starting when the Chairman and Coordinator joined the Secretariat. SP-IPM staff also discussed about the future of the group in light of the new CGIAR Consortium Research Programs (CRPs) and the close of some system-wide initiatives.

The group agreed that a structure is needed for inter-disciplinary networking, maintaining the identity of the IPM research area within the CRPs, and to lobby for further investment in IPM-related research. Proposals have been forwarded on how this organization might look like to the Chair and Coordinator for their consideration.

New projects: implementing the SP-IPM research framework

This year has been another successful one for SP-IPM in terms of research proposals submitted to donors. SP-IPM proposals are developed by multiple member centers but submitted by only one on behalf of the others to encourage and enhance collaboration. These proposals complement on-going research of the individual member centers.

In 2011, we initiated two new projects funded by the German Government through the Federal Ministry of Economic Cooperation and Development

(BMZ) (see box below). Each project will run for three years.

New projects on the ground in 2011

Enhancing horticultural productivity, incomes and livelihoods through integrated management of aphid pests on vegetables in sub-Saharan Africa

This project will develop and implement ecological- and biological-based pest management options to reduce losses due to aphid infestations on okra, cabbage, and kale in sub-Saharan Africa, and build the capacities of NARS partners and farmers in the use of non-chemical alternatives to synthetic pesticides.

Overview: The melon/cotton aphid, *Aphis gossypii* is the main aphid that infests okra; while the cabbage aphid, *Brevicoryne brassicae*, and the turnip aphid, *Lipaphis pseudobrassicae*, are the predominant aphids of cabbage and kale, with the former being dominant in mid-altitudes while the latter is found largely in low-altitudes. Based on available knowledge, collectively these aphids can cause large losses in the yield and quality of their respective host crops through direct damage and transmission of viral diseases.

To combat these pests, growers apply large amounts of synthetic pesticides with little consideration for crop contamination, human and environmental effects, and the other negative consequences such as the disruption of naturally occurring biological control agents.

The project determines the level and dynamics of aphid infestations and the diversity and prevalence of aphid-transmitted viruses and their damage on the

targeted crops as well as the diversity and impact of predators, parasites and pathogens.

Appropriate user-friendly identification and monitoring tools are being developed and windows of opportunities for intervention are being identified. Detailed evaluation of promising natural enemies will be carried out and possibly new natural enemies or new strains introduced to complement existing ones.

Conservation biocontrol and biopesticides and natural products as alternatives to chemical pesticides will be tested and promoted. Aphid-tolerant/resistant varieties will also be identified and promoted.

Training and awareness building are being carried out to enhance appreciation of non-chemical alternatives and the adoption of recommended practices among NARS and farmers. Educational materials are being developed and used for training.

Participating countries: Kenya and Cameroon
Funding: BMZ (€1.2M)
Implementing SP-IPM members: IITA, AVRDC, icipe

Combating fruit flies and mango seed weevil through community-based implementation of a sustainable IPM program for mango in sub-Saharan Africa

Locally grown fruits such as mangoes are well recognized as an important source of income and foreign exchange in Africa. Over 80 percent of fruits and vegetable production is carried out by smallholders for both urban domestic and export markets of which the EU is the major export destination and the USA is an emerging market. Several factors, however, constrain fruit production

such as tephritid fruit flies (e.g. *Bactrocera invadens* and *Ceratitis cosyra*) and mango seed weevil (MSW) (*Sternochetus mangiferae*) that damage fruits and cause 40 to 80 percent yield loss depending on the locality, variety, and season.

Pest infestations not only reduce revenues and profits from local and export markets, but they also cause increasingly high production costs for smallholder growers and traders.

The project will implement IPM programs for the management of fruit flies and MSW that are based on protein baits, male annihilation technique (MAT), fungus-based biopesticides, biological control (e.g., parasitoids and weaver ants), "soft" pesticides, and orchard sanitation.

These methods have been proven to be effective in managing the target pests and minimizing the use of pesticides that leave unwanted residues, thereby facilitating compliance with standards required for export markets. In addition to these pre-harvest measures, hot water-based postharvest treatments for fruit flies will be developed and promoted to facilitate quarantine certification often demanded by export markets.

The project builds on the completed first phase of a mango IPM project funded by BMZ, which generated relevant knowledge base and the management methods for fruit flies and MSW mentioned above that are now ready for implementation.

Participating countries: Kenya and Tanzania
Funding: BMZ (€1.2M)
Implementing SP-IPM members: icipe, IITA

Also in 2011, BMZ approved four new projects that will start in early 2012. These are: "Local Focus: safe and effective pest and crop management strategies to strengthen the vegetable value chain in the humid tropics", which we will lead and implement in collaboration with AVRDC and other partners; "Beating Begomoviruses: Better livelihoods for farmers in tropical Asia with begomovirus-resistant tomato, hot pepper and mungbean, and integrated disease management", which will complement the latter project and will be implemented by AVRDC in India, Vietnam, and Thailand; "Implementation of integrated thrips and tospovirus management strategies in smallholder vegetable cropping systems of Eastern Africa", which will be conducted by icipe with AVRDC; and "Cost effective, farmer- and environment-friendly biocontrol of aflatoxin in chili peppers (*Capsicum* spp.)", that we will carry out in Nigeria.

Chili pepper for sale.One of SP-IPM's new projects will tackle aflatoxin in this "hot" vegetable. Photo by JT Oliver, IITA.

Financial Information

Funding overview

Funding for 2011 was US$47.427 million, of which 98.8% came from CGIAR investors and 1.2% from other sources. Expenditure was US$46.71million (net of indirect costs recovery of US$4.478 million), of which 85.2% was used for program expenses and 14.8% for management and general expenses.

The governments and agencies that provided the largest share of our funding in 2010 and 2011 are shown in Figure 1, while IITA`s 2010 and 2011 expenditures by program and CGIAR system priorities are shown in Figures 2 and 3, respectively. Performance indicators, as prescribed by the CGIAR, are reflected in Figure 4.

Figure 1. Funding: Top 10 donors, 2010 and 2011

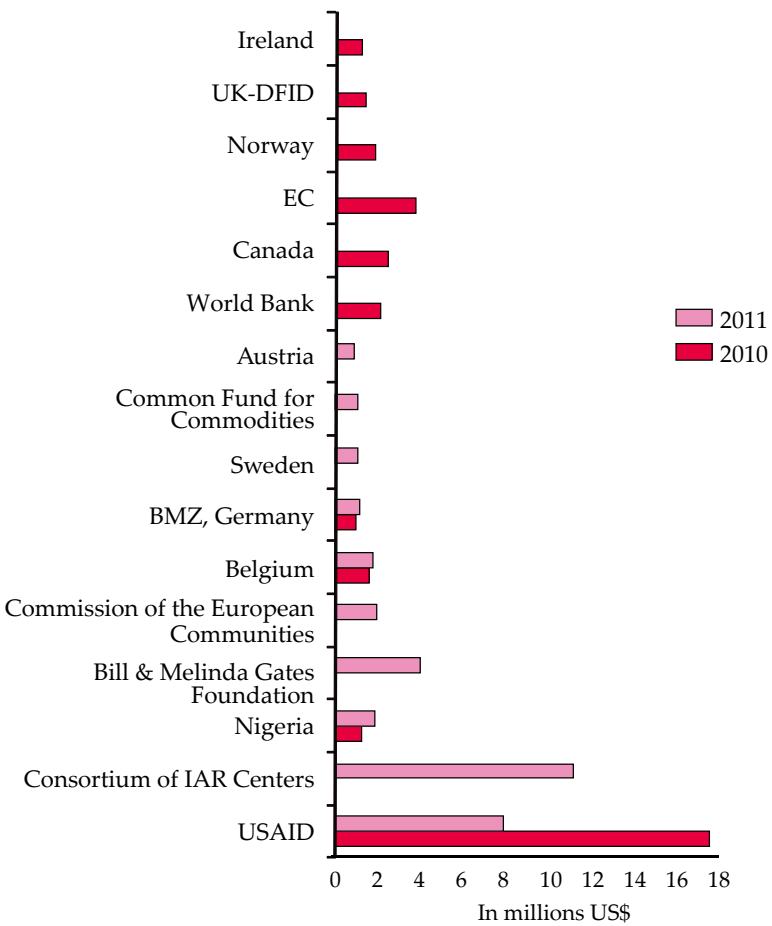
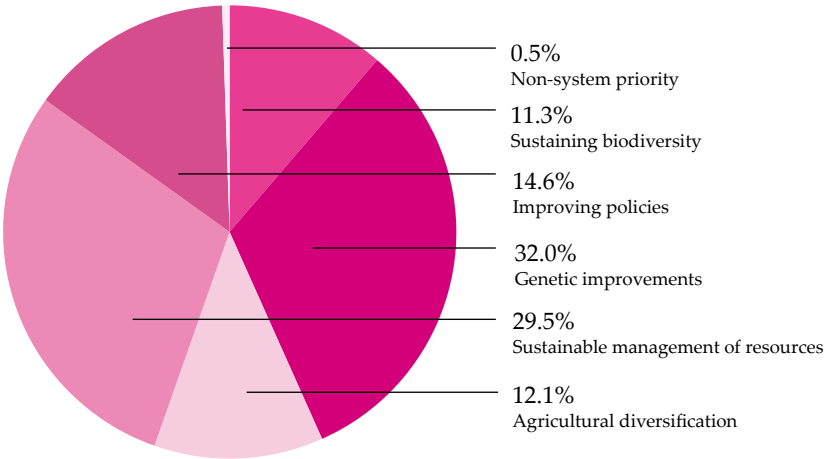
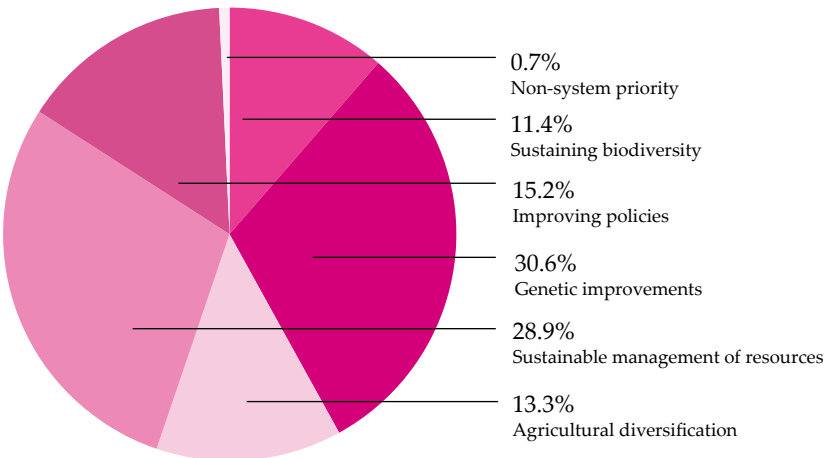


Figure 2. Expenditure by CGIAR System Priorities, 2010



Expenditure by CGIAR System Priorities, 2011



IITA Investors	2010 (expressed in US$ Thousands)	2011
African Agricultural Technology Foundation	246	513
African Development Bank	0	358
Austria	119	773
Belgium	1,544	1,732
Bill & Melinda Gates Foundation	0	3,961
BMZ, Germany	985	1,110
Canada	2,422	73
Catholic Relief Service	756	386
Chemonics International	619	8
CIMMYT	2,320	2,031
Commission of the European Communities	3,770	1,959
Common Fund for Commodities	586	1,011
Consortium of IAR Centres	0	11,271
Denmark	803	0
Department for Int'l Development, UK	1,296	0
ECOWAS	248	0
Food and Agriculture Organization	361	239
France	330	330
Gatsby Charitable Foundation	109	0
Global Crop Diversity Trust	528	314
ICIPE	193	246
ICRISAT	986	1,613
International Fund for Agricultural Development	686	132
IFPRI	135	402
Ireland	1,114	724
Italy	0	0
Japan	602	410
Korea, Republic of	40	0
Netherlands	766	495
Nigeria	1,207	1,890
Norway	1,750	78
Rockefeller Foundation	0	-1
Shell Petroleum Development Company of Nig. Ltd.	567	0
Sweden	512	1,018
Switzerland	478	173
United States Agency for International Development	17,818	7,929
W. K. Kellogg Foundation	47	0
World Bank	2,026	55
Miscellaneous Projects	4,368	3,751
Challenge Programs	2,111	1,872
Grand Total	**52,448**	**46,856**

Figure 3. Expenditure by CGIAR System Priority: 2010 and 2011

	2010		2011	
System Priority	Cost ($`000)	%	Cost ($`000)	%
SP 1: Sustaining Biodiversity	5,973	11.3	5,312	11.4
SP 2: Genetic Improvements	16,964	32.0	14,294	30.6
SP 3: Agricultural Diversification	6,398	12.1	6,192	13.3
SP 4: Sustainable Management of Resources	15,625	29.5	13,485	28.9
SP 5: Improving Policies	7,714	14.6	7,079	15.2
Non-System Priority	285	0.5	348	0.7
Total	**52,959**	**100**	**46,710**	**100**

Figure 4. Performance Indicators: Financial Health

	2010	2011
Short-term Solvency (or Liquidity)	135 days	159 days
Long-term Financial Stability (adequacy of Reserves)	135 days	159 days
Indirect Cost Rates	19.3%	17.5%
Cash Management on Restricted Operations	0.06	0.09
Audit Opinion	Unqualified / Clean Bill of Financial Health	

Soybeans ready for processing. Photo by JT Oliver, IITA.

Publications & Graduate Research

Publications

In 2011, we produced 294 publications, which comprised of 149 journal articles, 10 books/manuals, 22 chapters in books, 25 conference proceedings, 16 technical reports and 72 other publications (including abstracts/booklets). A total of 95 of the journal articles appeared in peer-reviewed journals that are listed in Thomson Scientific/ISI. The complete listing and details of these publications can be found in our online bibliography at http://biblio.iita.org/.

Graduate research

Individual training

During the year, we admitted 34 graduate students from various African countries and supported 123 continuing students in different disciplines within our various programs. We also trained 12 RTAs/interns from national system partners on breeding, soil science, and genebank activities. We also received and trained 124 youths from the National Youth Service Corps of Nigeria and industry student-trainees.

Group training

We organized 17 group training courses involving 3,852 participants (420 females and 3,432 males) in 30 locations on topics of agricultural enabling environments, productivity, food security, and new agricultural technologies and management practices.

In recognition of the increased necessity to enhance staff skills for better performance, we organized 24 in-house staff development training activities involving 373 Ibadan-based staff and 67 non-Ibadan based staff.

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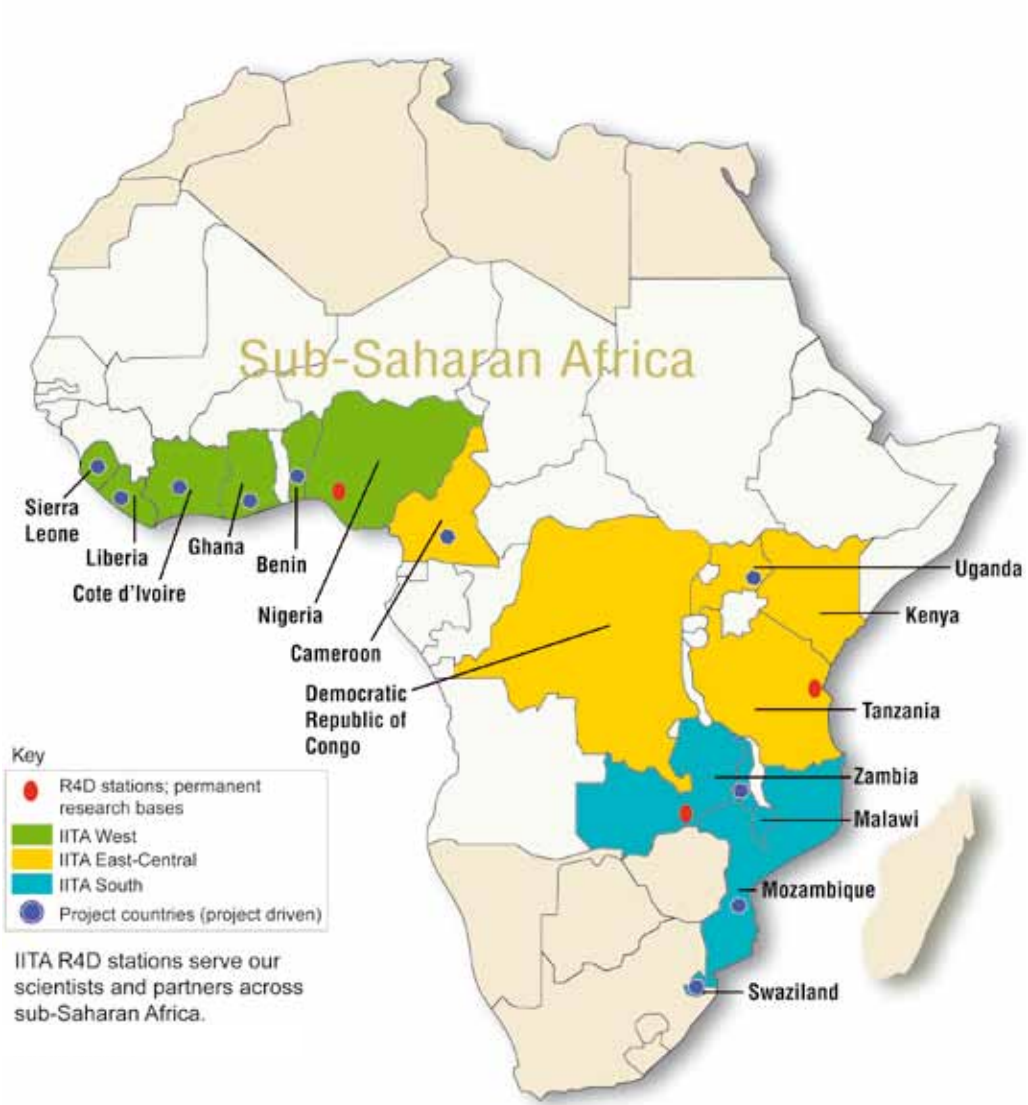

IITA R4D stations serve our scientists and partners across sub-Saharan Africa.

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A Rwandese soybean farmer tending to her young crop. Photo by JT Oliver, IITA.

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