IITA
Research to Nourish Africa

R4D Review

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Women beneficiaries of IITA projects.
Photo by IITA.

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EDITOR'S NOTE

The benefits of social science

Agricultural research is the key to achieving IITA's mission of enhancing food security and reducing poverty in sub-Saharan Africa. Hence, IITA undertakes research with and for the people and engages a whole range of partners along the research-to-development continuum. The effectiveness of this approach depends, however, on the richness of the social science context that is required to ensure the relevance of agricultural research in the discovery, adaptation, adoption, and diffusion of new technologies and institutional innovations.

The focus and methods of socioeconomics research, particularly of impact assessment, have evolved over time in response to donors' interests and research mandates.

Traditionally social sciences was narrowly defined and focused on working in collaboration with biophysical scientists on issues related to technology generation and delivery. The research agenda centered on several sets of key questions: the extent of and constraints to adoption; the impacts of technology adoption on yields and household incomes; and *ex-ante* (or expected) benefits from new technologies. From a rather narrow emphasis on the adoption of new varieties in the 1970s, the focus has now expanded to estimating rates of return to research investments in the 1980s and to examining a wider range of impacts and the distribution of benefits across different socioeconomic groups after the 1990s.

Currently, IITA's socioeconomists undertake a wide range of socioeconomic and impact assessment activities supporting broader technology development and delivery efforts.

This issue presents highlights of some recent research in socioeconomics and impact assessment and IITA's social science research agenda for the next decade. A set of studies addresses strategic, macro-level impact and policy issues and offers strategic information and analyses. For instance, one study showed significant productivity gains realized after the mid-1980s, driven principally by agricultural research and development (R&D), improved weather, and policy reforms.

Another study found that, with the successful implementation of emerging national strategies for the agricultural sector, agricultural growth is expected to increase from 4.6% under a business-as-usual scenario to 6.4% with the implementation of national strategies.

One study exploring technological and policy options for forest and biodiversity conservation in West Africa showed that strategies to reduce deforestation and conserve biodiversity must focus on transforming agricultural practices from traditional to modern science-based methods.

Several other recent studies also address the extent, determinants, and impacts of adoption of a range of production and processing technologies and institutional innovations developed and promoted by IITA and partners.

"Social science is a vital dimension to our biological science."

— DG Hartmann

IITA promotes the active participation of women in decision making in agriculture. Photo by IITA.

NEWS

Initiative tackles killer aflatoxin

IITA and partners recently launched a project that will provide farmers in Nigeria and Kenya with a natural, safe, and cost-effective solution to prevent the contamination of maize and groundnut by a cancer-causing poison, aflatoxin. It is funded by the Bill & Melinda Gates Foundation.

Aflatoxin is produced by a fungus (*Aspergillus flavus*). It damages human health and is a barrier to trade and economic growth. The toxin, however, is not produced in all strains of the fungus. The project's biocontrol technology introduces nontoxic strains of the fungus in the affected fields. These "good guys" overpower and reduce the "bad guys," the population of toxic strains, drastically reducing the rate of contamination.

During the launching of the project, Wilson Songa, Agricultural Secretary in Kenya's Ministry of Agriculture, said that Kenya welcomed the initiative after recent losses of lives and millions of tons of maize to aflatoxin contamination.

Maize cobs with fungus.
Photo by IITA.

"Kenya has become a hotspot of aflatoxin contamination. Since 2004, nearly 150 people have died after eating contaminated maize," he said.

IITA had worked with the United States Department of Agriculture to develop a biocontrol solution for aflatoxin, testing it in many fields in Nigeria. The project will take the biocontrol product, commercialize it, and make it available to farmers.

Ranajit Bandyopadhyay, IITA's plant pathologist, says the project is adding value to previous investments in biocontrol. It will support the final stage of commercialization of aflasafe™ in Nigeria and selection of the most effective strains, development of a biocontrol product, and gathering of data on efficacy in Kenya.

The Nigerian government has joined forces with IITA and the World Bank to help contain the contamination of food crops by aflatoxins. The collaboration will make aflasafe™ available to farmers to greatly reduce the aflatoxin menace.

The new approach is part of the Commercial Agriculture Development Program supported by the World Bank and implemented in Kano, Kaduna, Enugu, Cross River, and Lagos States in Nigeria.

In Nigeria, produce from resource-poor maize farmers faces rejection from the premium food market because of aflatoxin contamination.

In on-farm research trials in Kaduna State—north-central Nigeria—during 2009 and 2010, farmers who treated their fields with aflasafe™ were able to reduce the levels of contamination by 80 to 90%.

Reducing crop loss from *Striga*

Scientists based in Nigeria and Kenya started an initiative against two parasitic weeds that have spread across much of sub-Saharan Africa. These weeds cause losses of up to US$1.2 billion from damage every year to the maize and cowpea crops of millions of small farmers.

The project, coordinated by IITA, will introduce proven technologies for fighting *Striga* (witchweed), and *Alectra,* which attack crops such as maize and cowpea, reducing yields or destroying entire harvests.

Witchweed primarily affects smallholder farmers. The most widespread species is estimated to have infested up to 4 million ha of land under maize production in sub-Saharan Africa, with yield losses of up to 80%. IITA's researchers estimate that this represents about $1.2 billion in losses for farmers and affects approximately 100 million people in the region.

The *Striga* project is supported by a grant from the Bill & Melinda Gates Foundation. It aims at helping 200,000 maize farmers and 50,000 cowpea farmers who work in areas

with high rates of *Striga* infestation in Kenya and Nigeria. By the project's end in 2014, organizers estimate that farmers will see up to 50% higher maize yields and 100% higher cowpea yields.

The 4-year project will focus on improving and expanding access to methods of *Striga* control, while supporting research to identify the most effective means of control 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 2-year evaluation period, the project will scale up the most effective approaches.

Partners in the project are the International Maize and Wheat Improvement Center, African Agricultural Technology Foundation, International Centre of Insect Physiology and Ecology, and BASF Crop Protection. The poject will work with farmers, seed companies, community-based organizations, extension workers, policymakers, and researchers.

Scientists expect that the interventions will generate annually additional grain with an estimated value of $8.6 million at the project locations. This will result in increased incomes, better nutrition, and reduced poverty, and employment opportunities.

Extension worker explains about the Striga problem. Photo from SP-IPM.

A 'MIRACLE' in southern Africa

People affected by HIV/AIDS in southern Africa will benefit from a health and livelihoods initiative based on agriculture launched by IITA.

Making Agricultural Innovations Work for Smallholder Farmers Affected by HIV/AIDS in Southern Africa (MIRACLE) is a 3-year project. It aims at improving the health and nutrition status, food security, and incomes of people affected by HIV/AIDS in the subregion.

MIRACLE's key interventions include the production, consumption, and marketing of nutritious crop and livestock products, lobbying for supportive agricultural and health policies, and strengthening the capacities of stakeholders.
Project manager Melba Davis-Mussagy, IITA's Agroenterprise Development Specialist, says that the project will enable beneficiary households to produce their own nutritious foods and then use these to generate additional incomes. It will also develop and promote value-added products and processes using various nutrient-dense crops. It will advocate appropriate policy options to link agriculture and nutrition to improve the health status of people affected by HIV/AIDS and their families in the project sites.

MIRACLE is funded by the Swedish International Development Cooperation Agency. The project is being implemented in Zambia, Swaziland, Malawi, and Mozambique and works in partnership with various government agencies, NGOs, farmers' groups, and community-based organizations.

The project was officially launched in a ceremony held in Mukulaikwa, Mumbwa District, Zambia, in August this year.

New Director General

IITA has a new Director General: Dr Nteranya E. Sanginga.

Dr Bryan Harvey, chair of IITA's Board of Trustees, said, "Dr Sanginga was selected from an outstanding group. His achievements in reinvigorating the Tropical Soil Biology and Fertility Institute (TSBF) of the Centro Internacional de Agricultura Tropical (CIAT), and tropical experience make him an ideal choice to take on the much broader task of guiding IITA into the next decade."

"We are confident that under his administration IITA will continue its outstanding work in improving the lives of the tropical people in Africa and throughout the world," he added.

Having served as the Director of the Nairobi-based CIAT-TSBF, Dr Sanginga has more than 21 years of experience with the University of Zimbabwe, IITA, International Atomic Energy Agency in Austria, and CIAT-TSBF, in agricultural research and development, particularly in the fields of applied microbial ecology, plant nutrition, and integrated natural resources management in Africa, Latin America, and Southeast Asia.

Dr Sanginga is from the Democratic Republic of Congo (DRC). He did most of his postgraduate training at IITA and his PhD in Agronomy/ Soil Microbiology under a joint program between IITA and the Institut Facultaire des Sciences Agronomiques, Yangambi, DRC.

He has extensive skills in research management, developing partnerships and institutional linkages, and institution building. Under his leadership, the CIAT-TSBF portfolio rose from $1.2 million in 2003 to over $14.5 million in 2010. Its research-for-development agenda expanded

from focusing on western Kenya to covering the major agroecosystems of east, central, and southern Africa.

He has also played a major role in the creation of the Consortium for Improving Agriculture-based Livelihood in Central Africa (CIALCA) that includes three international research centers (IITA, CIAT-TSBF, and Bioversity), university partners in Belgium, national research and development partners in DRC, Burundi, and Rwanda.

During his career he has also focused on building the capacity of young scientists in Africa. He has trained more than 30 PhD candidates at the National University of Congo, School of Agriculture and the University of Zimbabwe, who now hold leadership positions in their countries.

Dr Sanginga had spent 14 years in IITA in various capacities, including principal scientist and head of the soil microbiology unit; project coordinator; and leader of a multidisciplinary program, collaborating with many scientists in national and international institutions.

Dr Sanginga succeeds Dr Hartmann effective November 2011.

Biocontrol offers benefits to Africa

Biological control programs implemented by IITA and partners on cassava green mite have brought benefits worth more than $1.7 billion to Nigeria, Bénin, and Ghana in the last 18 years.

Ousmane Coulibaly, IITA Agricultural Economist, describes the figure as "a conservative estimate."

"The figure represents the amount those countries would have spent over the years on other methods such as chemical control and/or yield losses if they never adopted biological control," said Coulibaly.

The cassava green mite is a pest that was responsible for a yield loss in cassava in Africa of between 30 and 50% until a natural enemy of the pest helped to contain the devastation. In 1993, scientists from IITA and partners identified *Typhlodromalus aripo* as one of the most efficient enemies against cassava green mite. The introduction of *T. aripo* reduced pest populations by as much as 90% in the dry season when pest populations are usually high; in the wet season, pest attacks are not as severe.

T. aripo from Brazil was first released on cassava farms in Bénin and, subsequently in 11 countries; it is now confirmed as established in all of them, except Zambia. *T. aripo* has also spread into Togo and Côte d'Ivoire from neighboring countries. It spread to about 12 km in the first year, and as much as 200 km in the second year. Today, the predator of the cassava green mite has been established on more than 400,000 km^2 of Africa's cassava-growing areas.

Scientists say chemical control of the pest was ruled out because of possible adverse effects of chemicals on illiterate farmers and the environment. Also, disease pathogens and pests tend to develop gradual resistance to chemical pesticides over time. Moreover, most chemical pesticides are not selective and might destroy the natural enemies and the pests together.

Coulibaly notes that since the release of *T. aripo*, benefits in Nigeria have been estimated at $1.367 billion, followed by Ghana $305 million, and Bénin $54 million. Consumed by more than 200 million people in sub-Saharan Africa, cassava is a staple food that is rich in calories, highly drought tolerant, thriving in poor soils, and easy to store in the ground.

Diseased soybean leaf. Photo by IITA.

From traditional to science based: Transforming agricultral practices

In recent times discussions on deforestation in the tropics more often than not have pointed to agricultural expansion as one major factor behind the depletion of forests.

This argument has been underpinned by the fact that agricultural growth in the region has been driven by area expansion rather than improved productivity.

Forests are crucial to life on earth. Photo by IITA.

Environmentalists say the depletion of forests hurts biodiversity, encourages climate change, and jeopardizes our future existence on this planet.

But a new study finds that increasing agricultural productivity through the application of fertilizers will reduce the rate of deforestation and help transform agriculture with less damage to the environment.

The study by researchers Jim Gockowski of IITA and D. Sonwa of CIFOR, two centers of the CGIAR, established that the boom in production in the last two decades in the major cocoa-producing countries of Côte d'Ivoire, Ghana, Nigeria, and Cameroon was detrimental to the forest, as farmers had to clear large expanses of trees for cocoa cultivation.

Cocoa production, they say, doubled between 1987 and 2007 but at a heavy cost, as West Africa's Guinean Rainforest (GRF)—a region described as the 'global biodiversity hotspot'—shrank to 113,000 km^2.

The principal driver of this environmental change has been the expansion of low-input smallholder agriculture that depends on environmentally destructive practices, such as slash-and-burn and land clearing.

The researchers found that increasing the use of fertilizer on cocoa–timber farms would have spared about 2 million ha of tropical forest from being cleared or severely degraded.

The study suggested that farmers could have achieved the same outputs without widespread deforestation through the intensified use of fertilizers and agrochemicals coupled with improved crop husbandry.

By doing so farmers would have doubled their incomes and helped to avoid deforestation and degradation. This would have generated a value of over US$1,600 million on 1.3 billion tons of CO_2 emissions that would not have come as a result of the deforestation.

The findings should be taken into consideration in discussions about efforts to reduce emissions from deforestation and degradation (REDD), say the researchers. Instead of considering complicated strategies involving monetary or in-kind transfers to farmers or communities for altering their land-use behavior, funds to support REDD could be used to provide incentives and promote agricultural intensification efforts that would lead to higher rural incomes, greater food security, and avoid emissions through the achievement of higher agricultural yields.

The limited use of fertilizer in the GRF (less than 4 kg/ha of total nutrients) may have been logical in 1960, when West African populations were only 25% of today's levels and forest land was still relatively abundant. That choice is no longer tenable in a context where only 15 to 20% of the GRF remain. There are no longer any frontier forests in West Africa for future generations to exploit.

Strategies to reduce deforestation and conserve biodiversity in West Africa must thus focus on transforming agricultural practices from the traditional to modern science-based methods. Fertilizers-for-Forest (F4F) technology is available to sustainably intensify production and has achieved impressive increases in cocoa yield on a limited scale in parts of the GRF.

The authors say that REDD funding support to mitigate climate change as discussed in the Copenhagen Accord offers the potential of significant new public resources for investments in agricultural research and extension and market infrastructure to support the transformation of traditional agriculture in West Africa. The estimated value of the CO_2 emissions thus avoided is conservatively estimated at $565/ha for achieving the envisaged doubling of yields. A significant proportion of REDD+ funding should be used to increase the adoption and level of fertilizer use in an F4F program.

Cocoa farmer drying beans. Photo by IITA.

Amazing maize: Investment in agricultural research pays off

Researchers have shown that investment in maize research in West and Central Africa pays off. A study by IITA's agricultural economists reveals that the generation and diffusion of modern maize varieties in the last three decades have lifted more than one million people in sub-Saharan Africa out of poverty.

Over half of this impact can be attributed to international maize research at IITA and the International Maize and Wheat Improvement Center (CIMMYT).

This was reported in a brief by the Standing Panel on Impact Assessment of the Independent Science and Partnership Council. The brief was based on the paper by Alene et al. (2009), who estimated the economic and poverty reduction impacts of international maize research in West and Central Africa from 1971 to 2005.

Based on data obtained from IITA's financial reports and the FAOSTAT database, a total of US$308 million was invested in maize research between 1971 and 2005, with international maize research accounting for about 66% ($204 million).

Maize research in West and Central Africa had been conducted by IITA, CIMMYT, and partners that include the national agricultural research systems (NARS). IITA, which has had a regional mandate for maize improvement since 1980, started maize research around 1970. With its partners, IITA had developed high-yielding varieties with increased tolerance for multiple biotic and abiotic stresses. As a result, these varieties have contributed to changing the status of maize from a minor crop to one of the most significant food and cash crops in the region.

Breeding programs at IITA and CIMMYT have been the major sources of germplasm for the released varieties, supplying 90% of the germplasm in the 1970s, 60% in the 1980s and 1990s, and 85% since the late 1990s. IITA currently supplies nearly 70% of the germplasm in the region, with little or no further improvement before the release.

In Nigeria, which accounts for nearly half the maize area in the region, 60% of the maize areas were planted to modern varieties in 2005. The total maize area tripled from 2.6 million ha in 1981 to more than 7 million ha in 2005, with the area under modern varieties rising sharply from 111,000 ha to 4.2 million ha. Adoption figures estimated from the early 1980s onwards suggest a steady growth in adoption in the region.

Why maize?

First, maize grows in a wide range of production environments, making it an important source of home-produced food. Secondly, it is a desirable cash crop, providing farmers with income and keeping market processes affordable for the urban poor. Thirdly, resource-poor farmers are able to adopt the predominantly open-pollinated modern varieties without having to buy fresh seeds each season.

Based on the germplasm, international maize research moved between 300,000 and 500,000 out of poverty each year. It is estimated that every $1 million invested in maize research by IITA lifted between 35,000 and 50,000 people out of poverty. With the involvement of NARS in maize improvement work,

Maize is a major food staple in sub-Saharan Africa. Photo by IITA.

national programs have also significantly contributed to poverty reduction efforts in the region, with over $100 million being invested since 1970.

Thus, the total net benefit from international and national maize research in the region for 1981–2005 is estimated at $6.8 billion, equivalent to 12% of the present value of total maize production over the same period. Annual net benefits increased from $43 million in 1981 to >$400 million in 2005, with an annual average of $274 million (in 2000 constant prices).

Maize improvement research in the region had a benefit-cost ratio of 21. This means that every dollar invested in maize research generated additional food worth $21. Estimates for country-level benefit-cost ratio ranged from 11 in Mali to 84 in Nigeria, with an average rate of return of 43% in West and Central Africa.

Bottom line

Maize research has generated a stream of benefits in the region, and is thus considered a worthwhile investment. This underlines the importance of international research.

Study results also suggest that poverty in the region could have been much worse had there been no research and improvement in maize yields, when pest and disease pressure, the decline in soil fertility, and expansion into marginal lands are considered.

Research on nonyield benefits, such as drought-tolerant maize and varieties for better nutrition, for example, may even show greater benefits, according to the study.

Maize research will continue to be a powerful factor in reducing poverty, according to the brief. However, impacts of research investments are conditioned by farmers' access to inputs, such as fertilizer, credit, seeds, extension and input-supply systems, and market infrastructure.

References

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Local seeds and social networks

Including seeds of local crop varieties in the relief seed packages distributed to small-scale farmers after natural calamities could help indigenous crop diversity to recover faster. In addition, existing social networks which act as vital channels for seed distribution hasten the recovery of diversity in disaster-affected communities. These are among the findings of a recent study by IITA that looked into the loss and subsequent recovery of cowpea diversity in Mozambique when widespread flooding, followed by severe drought, hit most of the country about 11 years ago.

Farmers in Mozambique usually receive relief seed packages as a stop-gap measure to alleviate the effects of natural disasters that often wipe out their crops. However, most of the seeds are generally of introduced and genetically uniform varieties purchased from markets or provided by seed companies or by well-meaning relief agencies, which slow the recovery of crop diversity.

The study noted that the speedy recovery of Mozambican cowpea diversity after the back-to-back disasters of 2000 was largely due to the exchange of seeds among farmers through making gifts and other social interactions involving friends, family members, and relatives within the same community or those adjacent to it. Morag Ferguson, a molecular biologist with IITA and one of the study's lead researchers, says that farmers in Africa traditionally grow many crops and several varieties of each crop on the same plot of land to cope with unforeseen economic or environmental instabilities. They usually set aside part of their harvest to serve as seeds for the next cropping season. They also share or trade some of these seeds with friends and relatives. When natural disasters strike, many farmers often lose the seeds that they have set aside and are forced to rely on relief seeds, buy seeds from the market, or receive seeds as gifts from friends and relatives.

Cowpea seed diversity. Photo by IITA.

"We found that the substantial recovery of cowpea genetic diversity two years after the calamities was mainly due to the informal exchange of seeds among farmers that served as a socially based backup for the safety of crop diversity. It is therefore important that seed relief strategies recognize and capitalize on this existing traditional network, based on social relations, to help restore diversity especially after natural upheavals," Ferguson said.

The study was initiated in 2002, two years after the floods-then-drought disaster, in Chokwe and Xai Xai districts of the Limpopo River Valley—areas that were among those severely affected. The findings of the research have been published in the current issue of *Disasters*, a publication of the Overseas Development Institute.

The research established that nearly 90% of the farmers in the affected areas received cowpea relief seeds immediately after the back-to-back calamities. Two years afterwards, only one in every five of the recipient farmers were still growing the seeds,

whereas more than half sourced their seeds from markets. However, this did little in restoring cowpea diversity in the affected communities as the seeds bought by farmers from the market were mostly uniform, since they came from other districts that grew just one variety or a few select varieties.

On the other hand, about one-third of the affected farmers obtained seeds from friends and relatives from nearby districts not affected by the disaster and with excess seed to restock their farms—the same people with whom they had been exchanging seeds before the disasters. This practice was the main reason why cowpea diversity was restored in these areas, the study showed.

Ferguson says that such a seed distribution system based on social relations is already in use in an approach developed and implemented by the Catholic Relief Services in partnership with other relief agencies in which seed vouchers are exchanged for seeds at "Seed Fairs". In this approach, farmers from nearby districts not affected by disaster and with surplus seeds come to the Seed Fair to sell seeds to disaster-affected farmers in exchange for vouchers, which they then cash-in with the relief agency.

"This approach recognizes that farmers' seed systems are robust and resilient, and can provide seeds even in emergencies. This study shows that such an approach will be more effective in restoring diversity faster and more efficiently than a system based on direct distribution only."

The study was the first of its kind to investigate in detail the effects of disasters on crop diversity and its recovery. It combined agronomic observations (e.g., looking at the seeds' color, size, pattern, and shape) with biotechnology tools to determine the seeds' genetic makeup.

Social networks provide a safety net for people affected by disasters. Photo by IITA.

What sustains the productivity of African agriculture?

A study carried out to measure productivity trends and the effects of research and development (R&D) in African agriculture shows that, over the period 1970–2004, African agricultural productivity grew at an annual rate of 1.8%. Agricultural R&D, improved weather, and policy reforms were found to be the principal drivers of the productivity gains realized after the mid-1980s.

The study by Arega Alene, IITA's agricultural economist, published in *Agricultural Economics*, showed that investments in agricultural R&D had an annual rate of return of 33%, proof that agricultural R&D in Africa is a socially profitable investment.

The study found that a strong growth of agricultural R&D investment of about 2%/year in the 1970s led to faster productivity growth after the mid-1980s, but stagnation of R&D investments in the 1980s and early 1990s led to slower growth in productivity in the 2000s.

Agriculture is key

Growth in agricultural productivity has been cited as the key to economic growth, and many researchers have in fact looked at the trends and sources of growth in agricultural productivity in developing countries. The extent of recovery of African agricultural productivity since the mid-1980s, however, varies widely, depending on the methods used to measure and explain it.

The study looked at total factor productivity (TFP) growth in African agriculture using available data on all African countries for the period 1970–2004. Data on agricultural production and conventional agricultural inputs for 52 African countries for the period 1970–2004 were obtained from the FAOSTAT database (FAO 2007). Meanwhile, data on agricultural research investments for 15 African countries for 1971–2001 were obtained from the Agricultural Science and Technology Indicators database of the International

Research and development has been one of the major drivers of agricultural productivity in Africa.
Photo by IITA.

Food Policy Research Institute (IFPRI). These countries were Bénin, Botswana, Burkina Faso, Côte d'Ivoire, Ethiopia, Ghana, Kenya, Madagascar, Malawi, Mali, Niger, Nigeria, Senegal, South Africa, and Zambia.

Using conventional indices of productivity growth, the study estimated that the annual aggregate productivity growth in African agriculture was only 0.3% over the period 1970–2004. The poor aggregate performance was due to a decline in agricultural productivity in over one-third of the sub-Saharan African countries. With an annual growth rate of only 0.1%, the conventional approach implied that the performance of agriculture in the region was poor and that agricultural productivity stagnated.

In sharp contrast, the improved measures of productivity showed that African agricultural productivity grew at a much higher annual rate of 1.8% over the period 1970–2004. In sub-Saharan Africa, agricultural productivity grew at an annual rate of 1.6% over the same period. As expected, North African countries experienced a higher annual productivity growth rate of 3.6%. Although 20 countries experienced annual productivity growth rates of over 2%, only seven countries (Burundi, Comoros, Democratic Republic of Congo, Côte d'Ivoire, Lesotho, Mozambique, and Sao Tome and Principe) experienced negative productivity growth rates, due largely to declining technical efficiency.

Technology drives agricultural productivity

Productivity decline during the 1970s was attributed to technological regress (−1.1%/year). However, technical progress (1.5%/year) was pinpointed to be the principal source of recovery of productivity during the 1980s.

The new measures demonstrated positive annual productivity growth in all three periods: 1970s (1.4%), 1980s (1.7%), and during 1991–2004 (2.1%). Unlike the conventional estimates, the improved measures demonstrated sustained increases in productivity growth over the years, with an impressive annual growth rate of over 2% achieved during and after the 1990s.

The results further showed that rainfall is positively and significantly related to agricultural productivity. This confirms that the weather is a critical constraint to agricultural production in Africa.

Despite the fluctuations in productivity induced by weather fluctuations, both trade and agricultural productivity exhibited an increasing trend after the mid-1980s. The results showed a positive and significant association between trade policy reforms and productivity in African agriculture, suggesting that policy reforms indeed contributed to the recovery of agricultural productivity after the mid-1980s.

In particular, agricultural productivity grew at an impressive annual rate of over 2% after the early 1990s. This is consistent with recent data on economic recovery in Africa, as shown by stronger growth rates in agricultural gross domestic product (GDP) following improved macroeconomic conditions and commodity prices after the mid-1980s. The results demonstrated that technical progress, rather than efficiency change, was the principal source of productivity growth in African agriculture.

Alene said that a 10% increase in R&D investments would raise agricultural productivity by 2%/year. With an annual rate of return of 33%, R&D has proved to be a socially profitable investment in African agriculture. The analysis points to the need for increased investments in agricultural research to sustain productivity growth in African agriculture.

Source

Alene, Arega D. 2010. Productivity growth and the effects of R&D in African agriculture. Agricultural Economics 41: 223–238.

Cassava processing research in Nigeria

Between 2002 and 2010, IITA implemented the Integrated Cassava Project (ICP) to support the Presidential Initiative on Cassava. Under ICP, IITA and its partners successfully introduced and promoted more than 40 cassava varieties to Nigerian farmers, and facilitated the establishment of hundreds of processing centers and fabricating enterprises.

The Presidential Initiative was launched in July 2002. It aimed to create awareness among farmers on the opportunities in the cassava markets worldwide, increase the crop's area of cultivation to 5 million ha targeting a harvest of 150 million t annually, and earn Nigeria up to US$5 billion every year from export, by the end of 2010. It also targeted to produce 37.5 million t of processed cassava products annually, such as *gari*, pellets, chips, starch, and ethanol for local and export markets.

The Nigerian government provided IITA some funds to assist in its R4D efforts and implement the ICP. The project had two components: the Cassava Mosaic Disease (CMD) Preemptive Project which focused on production aspects through breeding and distribution of improved varieties resistant to the virulent Uganda variant of CMD, and the Cassava Enterprise Development Project (CEDP). This promoted the development of enterprises associated with cassava processing.

Cassava for processing. Photo by IITA.

Through the project, IITA successfully introduced and promoted new varieties to farmers via the national agricultural research system (NARS), especially the Agriculture Development Program (ADPs). It also facilitated the establishment of many processing centers and fabricating enterprises between 2002 and 2010, contributing greatly to the development of the Nigerian cassava industry.

The study

A study was carried out to look at the impact of IITA's processing research on Nigeria's staple food system and to draw lessons from these interventions.

It addressed the following research questions:

- What is the level of awareness and adoption of improved cassava varieties, and other production and processing technologies?
- What are the effects of adoption of these production and processing technologies on farming households, their villages, the fabricators, and processors?

The survey was carried out in 70 villages in the four geopolitical zones in Nigeria: South-West, South-East, South-South, and North Central where 952 farmers, 143 processors, and 58 fabricators were interviewed.

Partial budgeting methods as well as micro-econometric evaluation methods

were used to assess causal effects based on the changes in outcome and impact indicators in areas with the cassava processing research interventions relative to those without the interventions.

Technology adoption and benefits: Village level

The results showed that from 2002, the area of land under cassava production had increased by 17% in intervention villages and by 10% in non-intervention villages. Also, the crop was found to occupy more than 70% of total area available for food crops in the sample villages.

Processing machines, such as graters, pressers, fryers, grinders, dryers, and millers proliferated in intervention villages; small percentages of other processing machines, such as boilers and fermentators, were also found.

Cassava produced by farming households was consumed or sold, fresh or processed, with some going to waste. There was a decrease in the proportion of waste over the years in both villages; the same was observed in the sale of fresh cassava roots. On the other hand, the volume of processed cassava increased over the years, suggesting the positive influence among cassava farmers of the government's efforts to boost production and processing.

Gari and *fufu* remain the most popular cassava products as they were a decade ago. However, in all villages especially in those where interventions were introduced, odorless *fufu*, starch, and chips were becoming increasingly popular. Other products such as cassava flour and ethanol were found but in small quantities and only in the intervention villages.

Technology adoption and benefits: Farming households

Cassava was the most important crop grown followed by yam, maize, and plantain/banana, among others.

Women making gari. Photo by IITA.

It occupies about 43% of the total cropland in the study areas.

The adoption rate for improved cassava varieties varied among farming households: 74% in intervention villages going up to 94% among those that had attended R4D training and 65% for the other locations.

On the adoption of processing machines, the grater was the most important with 60% adoption in intervention communities and 76% among those that had attended R4D training. It was followed by the presser; the adoption rate for other processing machines was found to be generally low.

Results also indicated that the adoption rate of improved cultivars was significantly greater in intervention villages than in nonintervention villages, with the use of graters for processing cassava having a positive and significant influence on adoption of new varieties. Factors that influenced the intensity of adoption of graters included contact

with extension agents and the use of improved varieties, among others. Although adoption of varieties and the uptake of graters reinforce each other, the effect of improved varieties on adoption of graters was found to be stronger.

Given the greater influence of adoption of improved varieties on adoption of processing machines, a sequential approach should be used in technology delivery involving improved varieties and processing technologies. The sustainability of cultivation of improved varieties is ensured by the availability and use of cassava processing machines among the households in the villages.

Adoption of production and processing technologies took place mainly in the last 20 years, particularly in the last decade; 62% of respondents indicated that they started using improved varieties in the last 10 years, whereas 43% had started using the grater and 45% the presser. Responses were similar for other processing machines. This was the period when IITA and collaborators had intensified the push for production and processing technologies in Nigeria prompted by the Presidential Initiative.

Sorting cassava. Photo by IITA.

The number of households processing cassava into various products had increased by 21% compared with 10 years ago. *Gari* (57%) and *fufu* (30%) were the most popular products. The remaining 13% was shared by other products, including cassava flour and starch, among others.

The gross margin values and the benefit-cost (B:C) ratios were greater for improved cassava ($4090) per hectare than for local varieties ($1500). The B:C ratio was 3:9 in favor of improved cassava varieties with the difference being attributed to the relatively high adoption of both improved cassava varieties and various management techniques extended to and used by the intervention villages.

Fabricating enterprises

The study showed that 66% of the enterprises fabricating machines were small scale and that 79% of them were owned by sole proprietors. There were varying levels of awareness on the different types of processing machines with many fabricators using other machines not meant for cassava processing. Graters (85%) and pressers (83%) were the most popular machines fabricated, followed by grinders/millers (59%) and fryers (41%).

IITA-contacted enterprises performed better than the other fabricators. Factors influencing the numbers of machines produced included being a sole proprietor, year of establishment

Grinding cassava using a locally fabricated machine. Photo by IITA.

(2003–2010), experience in manufacturing machines apart from cassava-based types, availability of spare parts, contact with IITA/ collaborators, and revenue from selling the machines. However, being a sole proprietor and the availability of spare parts had the greatest influence on production.

Processing enterprises

Half of the enterprises interviewed said that they had had contact with IITA/ collaborators and 41% had participated in R4D training on cassava processing in Nigeria. The processing machines mainly used by these processors included graters (85%), pressers (67%), fryers (64%), and sifters (34%).

Adoption of cassava products, such as *gari*, starch, bread, high quality cassava flour (HQCF), instant *fufu*, odorless *fufu*, and broiler meal was generally low but still higher for those processors that came into contact with IITA than for those that did not. Adoption was higher for *gari* (70%), starch (14%), HQCF (16%), and odorless *fufu* (17%).

An analysis of *gari* processing showed that it costs less to use "machines only" for processing compared with "manual and machines" and "manual only". From the cost analysis, $92 was saved when using machines to process 1 t of fresh cassava into *gari* compared with manual processing.

In conclusion, results indicate that *gari* is still the most popular cassava product (80% of households and 70% by processing enterprises). Graters and pressers were the most widely used equipment in Nigeria. Although the study found some reduction in adoption due to the decline in the implementation of the Presidential Initiative, most processors and equipment fabricators were still operating in the area. Despite a slow growth, processing increased with a high adoption rate of improved varieties (68%) by farmers. Processing equipment, such as graters and pressers, are now being used widely.

BEST PRACTICE

Impact of cassava R4D on smallholder farmers

Does research-for-development (R4D) have an impact on small-scale farmers? The answer is a resounding 'yes' based on a series of impact studies on IITA's cassava R4D work in the Democratic Republic of Congo (DRC) and Malawi.

Democratic Republic of Congo
In DRC, an emergency response R4D program was implemented from 2001 to 2009 after the outbreak of the cassava mosaic disease. The study provided hard evidence of a clear impact on household access and participation in markets, adoption of improved crop varieties and crop management practices, plot yields, gross margins, and food security.

Overview
Cassava is the number one provider of staple food and wages in DRC, accounting for more than 70% of the annual crop area and supplying around 56% of the calories in the diet (FAO 2010). In 1996, a new, more virulent Ugandan strain of the East African Cassava Mosaic Virus (EACMV-Ug) was detected. By 2000, it had spread to most cassava-producing regions. Most of the widely planted varieties had no resistance to EACMV-Ug and it was feared that the disease would lead to widespread crop losses and food insecurity.

The emergency response program to the outbreak was started in 2001 and aimed at increasing farmers' income, improving food security, and nutrition, and reducing poverty. It was supported through a multi-donor funding basket.

The first phase was implemented from 2001 to 2006 in the western provinces of Bas Congo, Kinshasa, and Bandundu because there was war in the eastern part of the country. The second phase, from 2007 to 2009, was expanded to include the central and eastern provinces: Equateur, Province Orientale, Katanga, Kasai Oriental, Kasai Occidental, Maniema, Nord-Kivu, and Sud-Kivu.

The first phase focused on the rehabilitation of cassava production through the multiplication and distribution of clean planting material of existing, already released cassava varieties, breeding for improved varieties with resistance to the viral disease and acceptable consumer traits, and improved crop management technologies. The second phase added components of postharvest management.

The program was implemented through an agricultural R4D approach which brought together different R4D organizations into public–private partnerships with clearly defined roles. These included the Programme National Manioc (PRONAM) within the Institut National pour l'Etude et la Recherche Agronomiques (INERA), IITA, the South-East Consortium for International Development (SECID), FAO, Centre d'Appui pour le Développement Integral de Mbankana (CADIM), PACT Congo, community based organizations, farmers' associations, and village-level farmers' groups.

The impact
In-depth interviews with participants revealed four stages by which the program interventions had an impact at the farm household level.

First stage: IITA and INERA undertook the multiplication of breeder and foundation planting materials and the development of new varieties, crop management, integrated pest management, and processing technologies. SECID, FAO, and CADIM implemented rapid multiplication and the large-scale distribution of disease-free planting materials, using a quality control system of primary and secondary nurseries to ensure that large quantities of planting materials were supplied to farmers for establishing their crops.

The Bureau Central de Coordination (BECECO), a government clean seed multiplication and distribution program funded by the World Bank, supported the multiplication and distribution of planting materials and farmers' training. Community based organizations and farmers' groups established village-level nurseries for multiplying disease-free planting materials of improved varieties, mostly for farmers within their communities but for some in neighboring areas.

Discussions with researchers, implementation staff, and beneficiaries revealed that the program led to the following outputs:

- The formation of strong partnership and networking among researchers in IITA and INERA, FAO, SECID, CADIM, and PACT-Congo, farmers' associations, farmers' groups, and small- and medium-scale enterprises.
- Capacity building resulted in the build-up of knowledge, skills, and competencies at the individual and organizational levels for researchers in INERA, extension agents, farmers, farmers' groups, processors, and equipment manufacturers. Farmers' field schools helped farmers to gain experience.
- The development and release of disease-resistant improved varieties. When the program started there were no varieties resistant to EACMV-Ug but in 2–3 years, five varieties had been developed. Eleven additional varieties were released between 2005 and 2008.

Chikwangues, made from fermented and pounded cassava, for sale at Kolo Market, Bas-Congo. Photo by IITA.

- Crop management and crop protection technologies were delivered through breeding for disease and pest resistance, releasing predators for green mite control, and refining extension recommendations.
- Processing technologies and institutional innovations for organizing and linking farmers to markets were delivered after the adoption of improved crop management practices and expansion in cassava production in the targeted areas. Small and medium enterprises engaged in cassava processing emerged as a result of the improved processing technologies to expand their operations and market in micro-chips and other products, such as *farinha*, *gari*, and starch.

Second stage: During this stage the outputs were delivered to change agents, including INERA researchers, extension workers, NGOs, farmers' associations, and private sector companies, resulting in changes in their level of awareness, knowledge, and practices. The major outcomes perceived at the change agent level were as follows:

- Changes in the practice and behavior of INERA researchers, Government and NGO extension agents, processors, and equipment manufacturers.
- Development of supply systems for clean planting materials of improved varieties, advice on crop and postharvest technology management, locally manufactured processing machines and equipment, micro-enterprises engaged in cassava processing, improved quality of cassava flour, better output marketing and logistics of distributing cassava-derived products to urban consumers.
- Tissue culture and institutional arrangements for the multiplication and distribution of planting materials made possible the distribution of a cumulative total of 417,354,633 one-meter stem cuttings of disease-free improved varieties to 3,530,666 households from 2001 to 2008. However, the total planting materials distributed were sufficient for planting only a lower bound estimate of 166,942 ha, or about 9% of the total national cassava area cropped in 2007/2008 using FAO data or 10% using data from the Service National de Statistique Agricole (SNSA).

Third stage: Here, the research products were delivered to farmers, resulting in increased awareness, knowledge, and adoption of improved practices among farm households in villages exposed to the program's interventions compared to those living in other villages. Respondents interviewed in this study believed that farmers exposed to the program's interventions acquired new knowledge that mosaic is a disease. To get good yields, growers needed to obtain disease-free planting materials from INERA research stations or NGO multiplication plots instead of neighboring farmers. Farmers acquired knowledge on using phytosanitation to control the disease.

Fourth stage: Respondents perceived that R4D generated synergies between farmers' access to and participation in markets, on-farm productivity, and the intensiveness in which parcels of land were cultivated. This, in turn, accelerated the adoption of improved technologies and farm-level impacts. Households in intervention villages that participated in the R4D program were perceived to have achieved better yields, higher profitability, and greater food security than those that did not. Processing added value to the cassava produced in targeted areas and the products were increasingly being sold to urban markets.

The study

Primary data were collected through a questionnaire interview survey in 2009 to a randomly selected sample of households in areas where the program had been implemented and neighboring nonprogram areas. The survey used stratified random sampling to select contact households. A total of 521 households clustered in 52 villages were interviewed.

Bags of dried cassava chips in Mbuji-Mayi, DRC. Photo by IITA.

The study tested three hypotheses on the impact of the agricultural R4D program on farm-level outcomes of interest:

- The R4D program has causal effects on households' participation in markets.
- The R4D program generates synergies among improved varieties and crop management technologies and encourages their adoption by farm households.
- The R4D program helps households achieve higher plot-level yields, greater profitability, and improved household food security.

The study established that households in villages where R4D had been introduced had significantly higher levels of sales of cassava compared with households in villages without interventions. R4D was also found to increase the probability of a household adopting most of the technology options. There were high correlations among random utility components which provided evidence for the hypothesis that R4D generates synergies among improved technology adoption decisions.

The study showed that households who lived in intervention villages had significantly higher plot yields, gross margins, and food security than those in nonintervention villages. Marginal effects showed that household participation in a farmers' organization had the most impact.

The study concluded that the cassava R4D interventions were successful in increasing the outcomes. The finding that the R4D program had positive impacts on intermediate outcomes that can be observed in the short term suggests that the approach has potential for long-term impacts on final outcomes. This implies that policymakers can increase the impact of agricultural research on household food security by promoting agricultural R4D approaches together with the development of farmers' organizations.

Malawi

Cassava is the second most important staple in Malawi after maize. The two crops supply over 70% of calories in the diet and sometimes replace and complement each other in production and consumption. They are historically intertwined as both were introduced into Southern Africa from Brazil in the 1500s. However, the colonial and early post-independence agricultural policies favored maize and, as a result, cassava production remained insignificant throughout this period.

The situation, however, changed dramatically between 1994–1995 and 2006–2007 when the area grown to cassava more than doubled and production expanded. This was as a result of a combination of factors including (1) realignment of commodity prices in favor of cassava over maize after the removal of consumer and producer subsidies under structural adjustment; (2) development, dissemination, and adoption of improved technologies; (3) extension to popularize cassava; (4) the collapse of input supply, credit, and maize markets; (4) a decline in soil fertility below the economic yields for maize; and (5) high rainfall variability.

The spread of HIV/AIDS may have also contributed by reducing the rural labor supply and replacing high-labor intensive crops such as maize with labor-saving, low-input crops such as cassava. There was an increased demand for fresh and processed cassava in central Malawi as consumers substituted cassava for more expensive maize and wheat products.

A study applied econometric modeling treatment effects methods to estimate the impact of the cassava R4D projects implemented in Malawi in the 1990s and 2000s on the farm-level yield, per capita area planted to cassava, and food security.

Overview of the program

Formal cassava improvement research started in 1930 in Karonga with the collection and evaluation of local varieties for their yield potential and resistance to cassava mosaic disease. Varieties from Malaysia, Java, Kenya, Tanzania, Trinidad, and Ghana were introduced and evaluated.

Notable highlights include the severe drought and famine in the years 1948–1949 and 1949–1950 that led the Department of Agriculture to distribute cuttings as a drought recovery intervention. However, these years were followed by three consecutive good rainfall seasons that resulted in sufficient maize production, large surpluses of cassava which were not sold due to lack of transport, and reduced interest in the crop except in areas where it was already a staple food.

During the 1950s and 1960s, researchers continued to search for mosaic-resistant varieties from the East African Agriculture and Forestry Research Organization. Agronomic trials were also conducted on intercropping, planting time and method, spacing, harvesting, fertilizer use and land preparation, and on pest and disease control. The findings were formulated into recommendations and made available to extension for dissemination to farmers.

Postharvest management research was conducted to develop technologies for processing cassava into flour on a large scale by agribusiness companies. In the 1950s and 1960s, the crop began to emerge as a cash crop in the southeastern districts when private traders exported surpluses of dried cassava to East Africa and the European Common Market. At its peak in 1968, the crop was the fifth highest foreign exchange earner in Malawi after tobacco, tea, groundnut, and maize. But the quality of the dried chips was low because of poor processing methods and could not compete with cassava pellets from Thailand.

From 1978, a parallel cassava research program was set up to evaluate materials from IITA. The breeding scheme used at IITA was introduced to shorten the

time taken from identification to variety release, multiplication, and distribution of planting materials to farmers. This resulted in the release of second generation bitter varieties tolerant of cassava mosaic and mealybug in 2000. These were Mkondezi (MK91/478), Silira (TMS601428), and Maunjili (TMS91934). In 2002, the national cassava program released two other cassava mosaic-tolerant bitter varieties, Yizaso (CH92/112) and Sauti (CH92/077).

At the beginning of 1985 there was a serious outbreak of cassava mealybug in the main cassava-growing areas but scientists brought the pest under control in the 1990s by exporting and releasing its natural exotic enemies from IITA.

During 1991–1992 and 1993–1994 there were severe droughts followed by low rains in 1994–1995. In response, the national cassava research and extension programs expanded and accelerated the multiplication and distribution of planting materials for cassava and sweetpotato. This was followed by another food security project from 1998–1999 to 2000–2001 which also incorporated postharvest technologies.

The projects resulted in major changes in the organization and implementation of cassava research. The first change was the smart borrowing of IITA's procedures for large-scale tissue culture, the rapid multiplication of virus-free planting materials, and distribution systems. The systems consisted of farmers' groups, researchers, extension agents, traders, processors, religious groups, community based and nongovernmental organizations, and policymakers. Also involved were Bunda College of Agriculture, Natural Resources College, IITA/SARRNET, International Potato Center, FAO, United Nations Children's Fund, and donors (Office of Foreign Disaster Assistance/United States Agency

Women peeling cassava for processing. Photo by IITA.

Cassava harvest. Photo by IITA.

for International Development, United Nations Development Program, and International Development Research Centre).

The first multiplication and distribution project focused on the supply of "cleaned" cassava cuttings of improved varieties through a quality control system of primary, secondary, and tertiary nurseries, on-farm technology evaluation and dissemination of improved crop management practices, the development of farmers' organizations, training, capacity building, and networking.

The second project placed more emphasis on postharvest management and market development. The components were implemented as a package in target areas selected as being food insecure suited to cassava production, and suitably located to minimize the costs of transporting materials from primary multiplication sites at government research stations, agricultural colleges, irrigation schemes, and agricultural training centers and from secondary sites in NGO intervention areas. The planting materials were supplied, based on availability and farmers' requests, to villages through farmers' groups and distributed through farmer-to-farmer exchange.

Research findings and conclusions
The study found that the cassava R4D program benefited smallholder farmers and generated significant farm-level impact. Using synthetic control methods to control for observable characteristics it showed that by 1995 annual yields in predominantly cassava-growing and -consuming districts first exposed to the program were about 23% higher than they would have been in the absence of the program.

The study estimated an increase of 14% in per capita area cropped to cassava among households first exposed to the program compared with those that were later exposed. The cassava R4D program led to an average increase of 9.1% for the 1997–1998 cross-section, 9.5% for the 2004–2005 cross-section, and 8% in the before and after changes for households per capita area planted to cassava.

Using the Heckman's treatment effects model to control for observables and unobservables, the study estimated that participation in the program increased the months a household can meet its minimum caloric requirements from home-produced maize and cassava staples by 66% for a randomly selected household, 18% for those actually selected in the program, and 22% for those at the margin of participation.

Therefore, increasing the impact of cassava R4D at a greater scale requires further investments in an adequate supply of planting materials and market development to transform cassava into both a food and cash crop.

People's stories

In this issue, R4D Review features success stories of farmers and end users who benefited from projects that IITA and its partners are implementing in the region to help address poverty and food security, improve health and nutrition, invigorate livelihoods and communities, and conserve the environment.

Training farmers in processing. Photo by IITA.

Promoting Sustainable Agriculture in Borno State (PROSAB)

In 2009, the Canadian International Development Agency (CIDA)-funded PROSAB project in northern Nigeria ended after 5 years. Overall, farmers who participated in the project have seen an 81% increase in their incomes from improved yields, better access to farm inputs and social empowerment—key interventions of the project. Farmers attribute this mainly to improved yields, better access to farm inputs, and enhanced agricultural skills brought about by the interventions of the project.

Government officials, participants and local partners say the project has helped significantly increase agricultural productivity and build the capacity of thousands of farmers and farmers' associations in the northern Nigeria state.

Analysis of the 17,000 households, or more than 100,000 farmers, that participated in the project showed that poverty levels dropped by an average of 14%, while food security improved by 17%.

Woman beneficiary of PROSAB's interventions. Photo by IITA.

PROSAB was managed by IITA with partners including the International Livestock Research Institute (ILRI), Borno State Agricultural Development Programme, CRED, the Institute of Agricultural Research-Zaria, and the University of Maiduguri.

The project introduced improved crop varieties, trained farmers on improved agronomic practices and promoted gender equality in agricultural development.

Apart from reducing poverty in households from 63% to 49%, the project also made significant inroads in increasing women's participation in agricultural activities.

Borno is predominantly Islamic with social interactions between men and women largely restricted by cultural norms. PROSAB introduced interventions that encouraged women to work alongside men for development.

Pa Buba Kayamda and son James are lead farmers from Nggabu, a poor rural community in Hawul Local Government, Borno State. Prior to 2004, the Bubas were just one of the many poor families in their community. They are one of the many beneficiaries of PROSAB's interventions.

The Kayamdas had abandoned maize farming five years ago because witchweed (*Striga hermonthica*) blighted their farms. The parasitic weed infests some 50 million ha of cereal crops in sub-Saharan Africa, specifically maize, sorghum, and millet. It affects over 300 million people in the region with farmers losing an estimated US$7 billion per year.

IITA—through PROSAB, introduced improved soybean and maize that are drought tolerant and/or resistant to *Striga* in Nggabu. Farmers planted improved soybean in rotation with *Striga*-resistant maize.

Today, *Striga* infestation on Kayamda's farm has decreased by over 90%, and maize and soybean yields have increased by over 150%.

The Wandali and Nggabu communities had chosen Pa Buba to produce seeds for the community, while James leads the youth farmers' group. Both father and son are members of a seed cooperative that produces healthy soybean and maize seeds for farmers in southern Borno.

Father and son have succeeded where few farmers in the community have not. The Kayamdas' openness to new ideas and their willingness to take risks contributed to increased prosperity.

Another beneficiary, Bata Joshua, is one of the leading members of the women's group in a community called Vinadam also located in the Hawul Local Government.

A farmer and his seeds.
Photo by IITA.

When asked how PROSAB has contributed to the community's livelihoods, she stated: "Prior to the introduction of PROSAB in our community, our harvests couldn't feed us for the whole year. We had to supplement by buying grains from the market. Presently, our harvests are sufficient to feed our families and we even have surplus to sell in the market."

"PROSAB has helped us freely interact with our male counterparts in development projects. We are not ashamed anymore," says Ruth Dasika Mshelia, a mother of five children and a participant of the project.

Building the capacity of farmers, entrepreneurs, producers, and extension workers in areas such as the proper use and handling of pesticides, sustainable crop production methods, seed production techniques, crop management, field evaluation, market opportunities, and access to credit, among others, has provided these beneficiaries in Borno with knowledge and skills to improve their self-worth, their livelihoods, and their communities.

Training through PROSAB has also created awareness among the beneficiaries on market opportunities, encouraged enhancement of linkages among suppliers and

processors, increased credit access, increased production and sales of seed and grains, promoted the use and processing of crops such as soybean, increased food supply, stimulated market growth, and empowered residents to go into business.

For instance, with the help of PROSAB, 308 seed producers—201 males and 107 females—have sold a total of 86.3 million t of seed worth 65.9 million naira or almost US$440,000; and about 260 farmers (106 males and 154 females) paid about 8.75 million naira or US$58,333 in credit.

Ndirwa, one of the women farmers who was a beneficiary of PROSAB interventions, testified that the project raised her farm productivity and incomes, with her yields of cowpea and maize almost tripling.

She added that other participating farmers whom she knew also had impressive yields during the span of the project.

Sudan Savanna Task Force of the Kano-Katsina-Maradi Pilot Learning Site of the sub-Saharan Challenge Program (SS TF KKM)

Mohammed Mustapha is a farmer in Kunamawa Village in the Safana Local Government of Katsina State, northern Nigeria. He is one of the

A farmers' field day shows off improved cowpea varieties. Photo by IITA.

farmers who received improved seeds as part of a package of innovative agricultural practices from the project.

Local farmers say that the improved seeds have helped raise their incomes, and improved their health and agricultural productivity.

"My family is happy because I am now a successful farmer. I can feed my family and send my children to school," says Mohammed Mustapha.

As a participant in the project, he has seen his cowpea yield double on the same plot of land but using the improved seed and agronomic practices. This was possible because of the training and improved seeds from the project.

"From two bags, I am now getting five bags from the same field—that is more than double the initial amount."

Hajia Birta Garbia, who heads a women's farmer group in the Bunkure Loval Government Area of Kano State, said that the drought- and *Striga*-tolerant varieties are helping farmers in her group to overcome the negative effects of climate change in the region. The varieties have raised yield by more than 100%. She used to get one and a half bags of cowpea, but now she harvests nothing less than four bags.

The northern part of Nigeria is rich in arable land but is plagued by myriads of problems that reduce agricultural productivity. These include the predominance of parasitic weeds such as *Striga* and *Alectra*, and pests which lower yields of major cereals and legumes, poor

Farmer Mustapha harvesting cowpea in Katsina, northern Nigeria. Photo by IITA.

soil fertility, ineffective extension systems, poor crop management, poor access to information, dysfunctional markets, and postharvest losses. The project, funded by the Forum for Agricultural Research in Africa, is working to minimize the effects of these constraints and also to enhance the marketing opportunities for farmers in the region.

Unleashing the Power of Cassava (UPOCA)

In 2009, IITA and partners, with support from USAID, launched UPoCA to help increase cassava production and processing, and thus ensure food security. The project is implemented in seven African countries—Nigeria, DR Congo, Ghana, Malawi, Mozambique, Tanzania, and Sierra Leone. Through the project, women and farmers have improved their livelihoods and food security through cassava value addition. Here are some success stories of farmers who have benefited from the project.

Sierra Leone
UPoCA is helping to rebuild the agricultural sector of war-ravaged Sierra Leone by improving crop yields and creating wealth in local communities through cassava value addition. As a result, cassava production in the country has increased, prompting the need for value addition and diversification of crop use.

UPOCA helped start the Tongea Women's development association in Sandeyalu, which is helping the residents to become gainfully employed with the establishment of a microprocessing center for cassava; opening up of 5 ha of land to cassava production; distribution of improved cassava varieties by IITA to more than 500 farmers; IITA-conducted training on cassava processing, product development, and packaging.

Maria Borbor, a member of the Tongea women's development association, described the establishment of the microprocessing center intervention as a "living bank".

"Now we can fulfill our financial obligations to educate our children and improve our livelihoods. We will do all within our power to sustain the microprocessing center, which provided a financial window of opportunity to us farmers, as a viable asset."

Another member of the group, Mariama Koi-Braima, secretary-general of the group, said, "We have come a long way to where we are today.

The journey has not been easy most times but we have determined to stay together. Handing over the microprocessing center to our group is going to reinforce cohesion among our members as it has demonstrated that worthy ambitions can be achieved through unity for a common good."

Because of the civil war in the 1990s, Sandeyalu was once overrun by rebels and the entire population had to take refuge in camps in nearby Kenema where they lived as internally displaced persons until the war was declared over in 2002. Thus, this project is helping rehabilitate the communities and lift people out of poverty.

In another town, Sagila in Kailahun District, a processing center was also established to provide resource-poor farmers in the community belonging to the Moamaleh Farmers Marketing Association with an income stream.

"With this facility and the products that we will be producing, we are sure that poverty will be reduced in our community, " says Mohammed Vande, chairman of the farmers' group.

Vande and his team of more than 30 youths are cultivating 2 acres of improved cassava from IITA. The center not only helped to process cassava in the community that is rotting on the ground, it has also created jobs for youths in the community.

In another part of the country, farmers are cultivating large areas to improved cassava varieties from IITA.

Ages Mamie Gbanie, a group leader and mother of seven, is among the beneficiaries of improved cassava varieties. She and her group cultivate about 23 ha of cassava. Gbanie has also benefied from a capacity building workshop organized by IITA. After the training on *gari* processing, Gbanie organized the women in her group and processed 200 bags of *gari* which they sold to the market.

Gbanie, who leads the Mandu Women Group, said that her group works together and the proceeds from their efforts are offered to members as loans.

Farmer Seedi Samah, another beneficiary, now cultivates 53 ha of cassava. His farm is located near the Kpandebu Growth Center, a processing facility for cassava products established by UNIDO. He stands to gain by being the major supplier of cassava root to the enterprise which had remained dormant since its inauguration several years ago.

Cassava products produced by local communities are also now hitting supermarket shelves, opening up new processing options and opportunities for farmers and processors participating in UPoCA.

"We now process cassava into *gari*, cassava flour, odorless *fufu*, and tapioca," says Rhoda Akinola, a member of NETWEPS, a local NGO that is promoting the use of cassava. Akinola was introduced to the benefits of cassava after attending a workshop in IITA. Upon her return to Sierra Leone, she began to raise awareness on the potential of cassava as a poverty alleviation crop.

UPoCA helped build the capacities of farmers such as Akinola through hands-on training on innovative approaches on cassava cultivation and processing. Many other farmers have adopted the innovations and stepped up cassava cultivation.

"The multiplier effect has been wonderful. The acceptability of cassava products—cake and bread among others—makes things a lot easier," she said.

Marion Senessi, who runs Home Foods and Drinks Ltd. in the capital city of Freetown, says that her shop provides an urban market outlet for cassava processors. The shop is linked to UPoCA-trained

growth centers and farmer-based organization processors in rural Sierra Leone from where she gets her supplies of new cassava food products. She sells cassava-based products from her shop and also through big supermarkets and grocery stores in Freetown. Returns from the sale of cassava products are helping farmers and processors in meeting their daily needs and alleviating poverty.

Nigeria

In Nigeria, UPoCA focused on the distribution of improved cassava varieties and providing training to farmers and processors on processing and utilization, packaging and labeling.

The UPoCA project has been implemented in seven states across the country, including Oyo, Osun, Ondo, Ekiti, Kogi, Nasarawa, and Benue.

In Oyo State, Nigeria, over 300 farmers received bundles of improved cassava varieties (TMS 30572, TMS 98/0581, TMS 95/0289, TMS 91/02324, TMS 92/00057, and TME 419). The distribution was preceded by a hands-on training on cassava product development and utilization.

In Kogi and Osun States in the north-central zone, more than 600 farmers benefited from training on best farming methods and rapid multiplication of cassava, about 25% of whom were women. The farmers also received stems of six varieties of improved cassava.

Farmers participating in the project said that their cassava production had been boosted by the availability of improved planting materials, making food available and generating income.

"I now harvest more than 20 t/ha using the improved varieties. With local varieties, I used to harvest 10 t/ha," says Bashir Adesiyan, chairman of the local chapter of the Nigerian Cassava Growers Association in Ido community.

"During the harvest period, other farmers accused me of applying *juju* (supernatural or magical powers) on the farm, but I told them it was the improved cassava stems and training that I got from IITA that have made my farm better." Many other farmers in the community who participated in the project have experienced increased cassava yields.

A farmer receives cassava cuttings as planting materials from IITA. Photo by IITA.

Capacity building in Nigeria focused on training of trainers for farmers, processors, women in agriculture, and entrepreneurs on cassava processing and use, and packaging and labeling products. The training courses, which are 90% hands-on, aimed to provide trainers with adequate knowledge on cassava product development for value addition, and skills in packaging that would increase better patronage of new cassava products. Participants were trained on how to process 21 different products, including *gari*, soy-fortified *gari*, starch, tapioca granules, soy milk, high quality cassava flour, 10% high quality cassava flour composite bread products, and *chin-chin* (a snack).

Tanzania
Peter Mtoi, 61, and wife Mary, 51, are members of a local farmers' group called Wambato in Tongwe Village, Muheza district, Tanga region, that is involved in cassava processing. The farmers' group has benefited immensely from UPoCA with earnings increasing more than 10-fold.

"With the money I made from the sale of cassava planting material and the dividends I received from the group, I have finished constructing and equipping a video den and also installed a solar system to run the TV and DVD player. I will charge the villagers a small fee to watch news and movies," says farmer Peter.

His wife Mary adds that they have also purchased a commercial charcoal oven to bake bread and cakes made of mixed cassava and wheat flour to sell in the village and at the nearby shopping center.

Their brick and iron sheet house with solar panels stands out from most of the mud and grass thatched huts around them—a sign of higher income a a result of their new business ventures.

Christine George, another member who is a mother of one, now has a new source of income after attending a training on making products from high quality cassava flour under UPoCA. She makes and sells *chapati* (a round flat fried bread) made of mixed cassava and wheat flours to school children and the local community. She buys the cassava flour at a discounted price at the center. She also adds eggs and margarine to make them more nutritious and tasty.

"We were trained on how to make the cassava products more nutritious by adding soybean flour for protein. However, since we do not have soybean in Tongwe village, we substituted eggs, milk, and dried fish," she said. "The children now prefer these *chapati* and *mandazi* which are tastier and more nutritious."

She says she makes a profit of between Tsh 12,000-15,000 a week and saves Tsh 2,500 (Tsh 1500 = US$1). Before she started with her own business she worked as a casual laborer on other people's farms to supplement the income from her own farm.

Mary Lipande, 59, also sells snacks to school children made from a mixture of cassava and wheat flours. She says she makes a moderate profit of between Tsh 9000-12000 per week Before that she was selling coconut and making a profit of Tsh 3000 per week. She adds that last year, she sold planting material worth Tsh 750,000.

She says she is now able to help her husband meet the needs of the family including school fees for their two children in secondary school, clothing, and health care.

"We used to grow cassava for eating only. But now it's a commercial crop. We are making money from it. Today, I do not wait for my husband to do everything. He only contributes," she said.

She also explains that they now all look forward to holidays as they no

longer worry that they cannot afford to cook 'special' foods such as cakes and bread.

"We are able to celebrate the holidays well with our families. Our children are happy with all the delicious and nutritious food we make," she says.

By introducing new recipes that use cassava flour or a composite with wheat flour, the project has created additional demand and market for the flour in turn boosting cassava production.

Ten years ago, many farmers in Tongwe village had almost given up growing cassava following its devastation by the cassava brown streak disease (CBSD). All the local varieties were susceptible.

However, the Ministry of Agriculture, Livestock, and Cooperatives, introduced and tested six varieties that were tolerant of the disease. They selected one, Kiroba, which was sweet and high yielding.

In 2003, the farmers formed the group to multiply and spread Kiroba to other farmers in the village and beyond. They were also trained on good agronomical practices such as selection of good planting material, and when and how to plant.

The Sokoine University of Agriculture helped set up a fully equipped cassava flour processing center. The farmers purchased the bricks and provided all the construction labor.

In 2009, UPoCA chose the group as one of the beneficiaries of its capacity building activities aimed at boosting cassava production and processing in the country.

Selected representatives and Tabu Maghembe, the government extension officer working with the group, were trained on production of high quality cassava flour and new products and recipes, quality and safety management, and labeling, packaging, and marketing.

The group has since constructed a toilet at the center, raised the drying racks to avoid contamination by dust or domestic animals, and started using plastic bags to spread the cassava chips to dry. Simple rules such as cleaning the machines and covering with polythene bags before and after use, and washing hands before touching the cassava chips or flour have also been put into place.

The quality of their flour has also improved greatly and as a result, it is attracting more customers. Maghembe says that when the group was first established, it was processing 500 kg of fresh cassava roots per month. But now as a result of improved flour quality, packaging, and marketing, they are processing 5 to 6 t of fresh cassava per month.

They are selling the flour at between Tsh 650/kg-800/kg making more than three times the profit from the sale of fresh cassava roots. A kilo of fresh cassava roots yields half a kilo of cassava flour.

The group is now working on getting its flour certified by the Tanzania Bureau of Standards.

Training on cassava processing in Tanzania. Photo by IITA.

The group which currently has Tsh 2.5 million in its bank account, pays dividends to its members twice a year from the profits made. Last year, each member received Tsh 200,000 as dividend.

It also acts as a saving and credit group for both members and other farmers who borrow money for emergencies against the cassava in the field.

"If you need money either as a group member or a villager, you can use your cassava to borrow from the group. So we no longer worry about emergencies such as hospital and school fees," said Mary Mtoi.

In total, UPoCA has supported eight such processing centers in Tanzania, providing much-needed simple processing machines and planting material for high-yielding and disease-resistant varieties. It has trained 840 farmers on cassava production, processing, packaging, business plan development, and safety and quality management.

Most of the groups supported by the project had the same set of challenges: difficulties in processing cassava during the rainy season when drying takes a longer time, lack of a milling machine near the cassava source, and no source of adequate and clean water, among others.

The project is helping the groups find alternative dryers to enable all-year round processing to meet demand, purchase hammer mills, and construct water pumps.

All the groups have increased their incomes as a result of their own hard work and support by UPoCA and other project partners.

"We are ready to continue to grow from strength to strength. We started from the farms and now we are processing and selling to supermarkets in big towns. We are now eyeing markets outside the country," said Maghembe. "We attribute our success to the fact that we implement what we learn and our commitment to the group."

Mozambique

Ernesto Lopes is a retired agricultural extension officer in Nampula province, northern Mozambique. A few years ago he retired from his job to set up OLIMA (meaning 'to farm') Ltd. because he wanted to show what can be done with cassava as a source of both food and income.

"We started promoting cassava processing in Nampula province, which is the crop's number one producer and consumer in Mozambique. However, the transfer and uptake of the technologies have been extremely slow.

Many people continued with the tradition of boiling the tuberous roots to eat or manually peeling, sun drying, and pounding it into flour to make *karakata*, a local dish," he explained. "So I decided to show by example. Sometimes people need to see things practically to believe."

The 47-year-old father of nine set up the processing center in an abandoned garage of the Caminhos de Ferro de Mozambique (Mozambique Railway), borrowing old machines from the Agricultural Research Institute of Mozambique (IIAM). These included a chipper, graters, and a press to extract water from the grated cassava.

He started processing in March 2009, slowly experimenting with a few piles of the crop purchased from nearby farmers and processing them into cassava flour and starch. His confidence and the quality of his products increased after a training on cassava processing and utilization in December 2009 by UPoCA which one of his staff attended. He also added a new product, *rale*, a popular local dish in southern Mozambique and which is currently imported from Latin America.

"Although we had been processing flour and starch for several months,

the UPoCA training taught us better processes to make high quality cassava flour which has a wide range of uses and quality starch," he added. "We also learned to make *rale*. It is not eaten much here but it is only a matter of time. In the next 2 to 5 years, we will be eating it too."

Today, he says he buys truckloads of cassava from nearby farmers who are only too happy as it saves them a long trip to the market and because his prices are much better. He has seven permanent employees and in a month sells approximately 500 kg of the flour, 100 kg of starch, and 50 kg of *rale* to local consumers.

He has also started growing cassava on part of his 1,000-ha farm to diversify his source of raw material. In late 2009, he planted 8 ha with improved varieties from IIAM purposely to get planting material for an additional 100 ha in the following cropping season. He hopes to expand to 400 ha by 2015.

Judith Celeste Macuacua-Pinto founded Wissa Ltd. because she wanted to make the life of women easier. She thinks that women need not spend so much time in the kitchen after a long day at work.

She started with making and selling ready-to-cook blended cassava leaves mixed with garlic and raw pawpaw. Today Wissa Ltd. has grown into a small cottage industry with a diverse range of ready-to-eat and -cook food products. It is one of the enterprises benefiting from the UPoCA project in Mozambique.

The 56-year-old widow says she closed her kindergarten in Maputo and moved to Nampula three years ago when her husband died. She first started processing castor oil but it was not lucrative and so she changed to processing cassava leaves for making *mathapa*.

This local delicacy made of cassava leaves cooked in coconut milk and ground fresh peanuts is very popular in Mozambique but is tedious to prepare as the leaves have to be manually pounded to remove cyanide and soften them for cooking.

After a training in 2008 on cassava processing after which she received processing machines in October 2009, a 1-t/h chipping machine and 20 drying trays, she started processing cassava flour.

In 2009, she attended a series of training by UPoCA on processing cassava into highly marketable items such as high quality cassava flour, *rale*, and starch and making a diverse range of products from the flour and diversified her products further.

She has also adapted *rale* into *molina* also known as *lifete* in the local language. This is a traditional food made of finely ground *rale* mixed with peanuts or cashew nuts, and sugar that is very popular in southern Mozambique. She says it is slowly gaining popularity in the north as it is delicious, healthy, and ready to eat.

She was also trained on maintaining hygiene and safety standards, packaging and labeling, marketing, and preparing a business plan. She worked with a professional designer to make labels and has also sent samples to the government lab to get feedback on the nutrition and food safety. She is now working to get a bar code machine to enable her to sell her produce in the big supermarkets in Maputo and Nampula.

She is now also processing more than a ton of high quality cassava flour in a month.

She has worked with IITA to develop a business plan. She says this has been a very useful exercise that led her to realize she was selling her cassava flour at a loss.

"From the business plan, I discovered I was selling a kg of cassava flour at a price that barely met the costs of the packaging material, the content, and the labor costs. There

was no profit. So I have now adjusted my price accordingly," she said.

Democratic Republic of Congo (DRC)
A group of women in the hilly terrains of Miwazi, a small village in Kwilu district in Bandundu Province over 600 km from Kinshasa, the capital of DRC, have benefited from UPoCA's interventions.

Several years ago, they had watched the production of their staple crop dwindle, the roots become smaller and smaller and the leaves curl and turn a strange color. This was due to the cassava mosaic disease; only they did not know what it was until they interacted with the UPoCA staff.

"Each year we got less and less cassava. We did not know it was a disease and were worried because for us, no cassava means no food. If you have no cassava, it is like a death sentence; you are going to die," said Manunga Jeanne, 58, one of the women.

They are members of the Femmes Rurales pour Development (FRUD) which translates into Rural Women United for Development in Kwilu District. In addition to the training on the disease and how to control it, the project also distributed clean planting materials of high-yielding and disease-tolerant varieties.

They selected their best three varieities: Obama and Nsasi (help to raise children), from IITA, and Butamu (the sweet one) from the National Agricultural and Environmental Research Institute, INERA.

"These varieties are not only giving us big roots and many leaves, but they are not getting this disease," Manunga said. "And they make very tasty *chikwangue*. *Chikwangue*, made from fermented and pounded cassava, is a popular local dish in the country.

Similar to last year, they sold the roots to the Groupement des Paysans Agriculteurs de Miwanzi (GROPAM), an association of 36 farmers' groups including theirs, and distributed the stems as planting materials to neighboring farmers. They made US$5,000 from selling the roots.

Last year, the group which was formed in 2005 and has 150 members, received 600 bundles from UPoCA which they planted on their communal 15 ha land donated by a well wisher.

Harvesting cassava leaves. Photo by IITA.

The project also trained them on good farming practices to get maximum yield. From these, they were each able to get planting material for their individual farms and distribute to other surrounding farmers.

According to the president of the group, Jean Octave Mawika, all the 36 farmers' groups of GROPAM received planting material and training from UPoCA.

"We have distributed planting material to over 7,000 farmers," he said. "We did not have enough to give everyone, so there were those who, out of desperation, got some from their neighbors."

Mawika says GROPAM is also working hard to create awareness about the cassava mosaic disease through weekly radio shows in a local station, Radio Liberté.

"We raise awareness about the disease, its symptoms, and how to stop its spread. We are also telling farmers about the new improved varieties," said Mawika.

UPoCA has distributed over 2 million cuttings worth over US$100,000 to over 18,000 households, which is a small fraction of the total national requirement of 3.5 billion cuttings. People from all over the country come to UPoCA to ask for planting material. Through UPoCA and other projects, IITA and its partners have met 15% of the national needs for improved planting materials over 8 years.

After interacting with the UPoCA team and participating in a training series on processing cassava into high quality fermented and unfermented cassava flour, business and marketing skills, GROPAM quickly seized the business opportunity presented.

The association purchased machines and started to process the roots it purchased from its members and sell the flour to markets and supermarkets in Kikwit and Kinshasa. The venture has turned out to be very lucrative and the group is now working towards establishing a modern processing unit to produce 1,000 t of flour per day.

Another cassava processor in Bandundu province who benefited from UPoCA's capacity building is Placid Pieya from Kwenge village. He is now working to create awareness among the villagers on the new cassava processing technologies and change the quality of products and their reputation.

"Bandundu is known for having poor quality dried dark cassava which fetches a low price in Kinshasa. It is mostly bought by the poor. But this will change," he said. "We will soon have good cassava products like the ones from Bas-Congo."

He explains that the traditional way of processing the crop includes a week or more of drying on roofs of grass thatched huts during which mold grows on them, discoloring them.

However, he has learned about new ways to process cassava from UPoCA that results in high quality products. He received 900 bundles of cuttings which he distributed to 2,000 families in his and nearby villages.

Pieya learned to use a press to reduce the amount of time it takes to dry the fermented cassava. This makes it remain white and fetches a premium prize in the markets in Kinshasa and Kikwit. The project also provided him with a mechanical chipper that processes 8 t/day to replace his old one.

"The machines have reduced 5-7 days of drying to 1-2 days," he says. "The quality is now very good and I am selling my products at a much higher price. Just last week, I took 103 bags (50 kg each) of my dried cassava to Kinshasa."

He plans to expand and has bought spreading sheets to dry the grated

cassava and a boat to buy more raw material from further afield.

He has three permanent employees but also recruits many casual laborers especially for peeling the cassava.

Another entrepreneur beneficiary of the UPoCA project is Mafuta Kany Veronique, 34. She learned about cassava processing from a family friend who had been trained by IITA and who gave her some of the processing equipment to start her off in her business venture. She has received training on processing high quality fermented and unfermented cassava flour, business planning, packaging, and marketing. She is now planning to change the design and size of her packages. Currently, she is packing at 7.5, 15, and 30 kg which she sells to supermarkets, market stall owners, and individuals who come to her home. She will include smaller packages to give people more choice.

She is processing 40 to 75 t of fresh cassava per month with a monthly income of US$2,000 to 5,000. The fluctuation, she explains, is caused by the weather patterns as her production is greatly reduced during the rainy season due to the difficulty in drying.

She has developed a 5-year business plan to guide her business and hopes to now target industries. However, to do this, she will need a mechanical drier for all-weather processing. UPoCA is helping her to explore possible options.

The project has also upgraded her processing equipment to meet the required standards.

To improve the quality of processing machines, the project has also trained selected fabricators drawn from various parts of the country. One fabricator is Mamadou Ndjaye Kunga, 37, based in Kinshasa.

He now specializes on cassava processing machines such as hammer mills, graters, and chippers, which he sells all over DRC under the commercial label AGRIMAC.

His interest in cassava processing machines was spurred by a visit to Thailand in 2009 organized by an IITA cassava R4D project. He says he saw the big difference in the quality of their processing machines and those in his country.

UPoCA also connected him with two fabricators in Kinshasa that IITA had previously sent to Morogoro, Tanzania, for training on making quality machines under the cassava R4D project. He now works closely with them.

The challenge for the fabricators is getting the raw material as it is not readily available in DRC, says Mamadou who has had to travel to Dubai and South Africa in search of the stainless steel. He says he cannot keep up with the high demand for the processing machines as he manufactures them manually. He takes a day to make a machine and only makes on order.

Selling kimpuka, cassava mash, for chikwangue in Bas-Congo. Photo by IITA.

TOOLBOX

Funding agricultural R&D and meeting development goals

Investment in agricultural research and development needs to be increased to ensure Africa's food supplies. Photo by IITA.

Member countries of the Economic Community of West African States (ECOWAS) will need to significantly increase their investment in agricultural research and development (R&D) to achieve the aim of the Millennium Development Goal (MDG) of eradicating extreme hunger and poverty by 2015.

The focus on agricultural R&D stems from the fact that, for all ECOWAS countries, more than half of a 1% reduction in poverty at the national and rural levels can be attributed to the growth of the agricultural sector.

A study by the IITA-led Regional Strategic Analysis and Knowledge Support System West Africa (ReSAKSS-WA) finds that to achieve this remarkable agricultural growth, countries in this regional bloc will have to almost double their current share of agricultural spending.

On average, an agricultural funding growth rate of 18.3% is required to achieve the target 6% rate set out by the Comprehensive Africa Agriculture Development Program (CAADP). However, successful reform of public institutions could lower this share substantially, according to a report by Mbaye Yade and colleagues.

About CAADP

CAADP was initiated in 2002 by the African Union. It is a strategic framework which guides the development efforts and partnerships of African countries in the agricultural sector. It has, among others, the following objectives and principles at its core: agriculture-led growth for poverty reduction; increased funding for agriculture (10%), and at least 6% agriculture growth, all aimed at achieving MDG1 and other welfare targets; greater efficiency and consistency in the planning and execution of sector policies and programs; increased effectiveness in translating government expenditure into public goods and services; and expertise and mechanisms to measure performance against objectives regularly

and transparently, and keep policies and programs on track.

ReSAKSS-WA works with ECOWAS to provide strategic analysis, knowledge management and communications, and capacity strengthening, towards achieving the aims of CAADP.

To promote monitoring and evaluation, the African Union and the New Partnership for Africa's Development requested ReSAKSS to develop a monitoring and evaluation (M&E) framework which would guide the continent in implementing CAADP.

Working with national and international partners, ReSAKSS has since backstopped some member countries in developing their National Agricultural Investment Programs (NAIPs) with this aim in view.

Current scenario

The ReSAKSS study shows that, under current trends, expected performance in agricultural growth is projected to stabilize at around 4.4% by 2015. However, with the successful implementation of emerging national strategies for the sector, agricultural growth is expected to increase to 6.4% from 4.6% under a business-as-usual scenario. Even the CAADP target of 6% annual agricultural growth for each country is not sufficient to achieve MDG1 by 2015, except for Bénin, Burkina Faso, Cape Verde, Ghana, and Senegal. Therefore, other plans with additional efforts are projected for the other countries.

The first M&E report from ReSAKSS indicated that the average share of agriculture in the 2005–2008 period was 10% and above in Burkina Faso, Niger, Ghana, Senegal, and Mali. It was below 10% in Bénin, Gambia, Liberia, Togo, Nigeria, Sierra Leone, and Côte d'Ivoire. With regard to the planned 6% growth in agriculture, the average rate for Gambia, Nigeria, and Sierra Leone in the 2003–2007 period was 6% and above. For all other West African countries, the average was below 6%. Apart from the incidence of stunting among children, all major indicators of welfare show an overall improvement in living standards in the 2000s compared with the 1990s.

The incidence of poverty using the international threshold for comparison—the US$1/person/day—decreased by 18% in the 2000s compared with the 1990s. Per capita gross domestic product (GDP) increased by 35% between 1990 and 2008. The Global Hunger Index shows a 14% decrease from the 1990–2009 value. Overall, it seems that recent trends in welfare have been positive in West Africa.

What the future holds

Regional Agricultural Investment Programs (RAIP) under CAADP are being prepared and will be funded through various mechanisms. IITA should work closely with the regional economic communities or RECs in preparing such programs because of the Institute's wealth of experience in R4D work aimed at increasing agricultural productivity in Africa, in particular with ECOWAS in priority crops, such as cassava, maize, and rice. Already some discussions are taking place but these should be increased. Given the poverty challenges facing West Africa and Africa in general, all avenues for productive collaboration should be explored.

To implement the Africa-wide M&E system, the system has to be adapted in each West African country. Two requirements for this are the establishment of a SAKSS in each country, and consequently, the inclusion of the M&E indicators in the SAKSS and country's annual reports and surveys.

This would make M&E a routine and important activity carried out annually. In turn, this would provide each country with the opportunity to ascertain how much progress is being made and to change the aspects of a strategy that are not working in a timely manner.

Outcome mapping: a tool for monitoring and evaluation

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Many development practitioners are preoccupied with the identification and measurement of impact resulting from their research-for-development projects or programs. In many high-level meetings, the importance of results-based management that is goal-oriented and that emphasizes cause and effect of inputs, outputs, and impacts, has been emphasized and a large number of methodological guidelines have been developed.

One such guideline is the Logical Framework Approach (LFA). It is a hierarchical linear causal-effect chain presented at four levels (activities, outputs, outcomes, and impact). It is concrete and encourages the clear formulation of outcomes and goals/impact and the precise definition of quantifiable targets. Its major weakness is the attribution of cause and effect between the levels of outcome and impact (Jones 2006). In reality, this cannot be conclusively determined. Most impacts occur a long way downstream and may not be directly influenced by a single actor. In addition, the linear cause–effect thinking in LFA is a rather strong assumption and has been criticized by many practitioners.

The weaknesses in the existing tools, particularly in the monitoring and evaluation of developmental impacts, motivated the International Development Research Centre to develop a different approach, referred to as outcome mapping.

Outcome mapping

Outcome mapping is a method for planning and assessing the social effects and internal performance of projects, programs, and organizations (Earl et al. 2001). It helps a project or program team to be specific about its targets, the changes it expects to see, and the strategies it employs, and as a result, to be more effective in terms of the results it achieves. Results are measured in terms of changes in the behaviors of people, groups, and organizations, also known as "boundary partners" (Fig. 1) with which a project/program works directly. The project/program works with the boundary partners to effect a change but it does not control them.

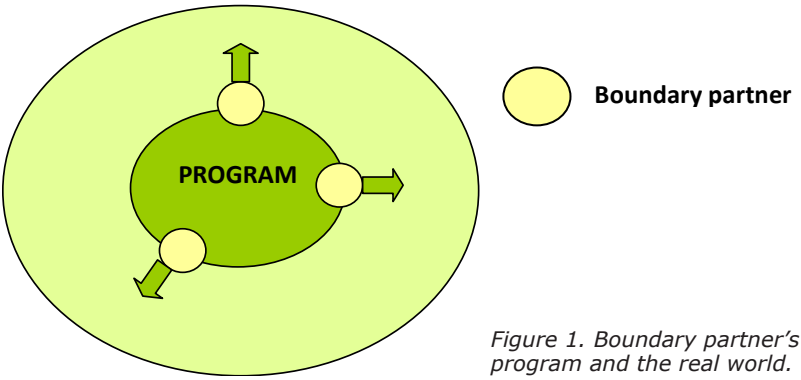

Figure 1. Boundary partner's link to the program and the real world.

Figure 2. Progress markers of a boundary partner. *Source: Jones 2006.*

The changes are referred to as outcomes. In so doing, outcome mapping clears away many of the myths about measuring impact and focuses more on social changes within complex and dynamic partnerships. Once boundary partners have been identified, outcome mapping differentiates the levels of behavioral change which may be seen among the partner organizations—known as progress markers. These are grouped according to expected behaviors (early positive responses), desired behaviors (active engagement), and hoped-for behaviors (deep transformation in behavior) (Shaxson and Clench 2011). In the vocabulary of outcome mapping, these are behaviors we would 'expect to see", "like to see", and "love to see" and they may be priorities for change or a time sequence of activities, or a mixture of both (Fig. 2).

Attribution and measurement of downstream results are dealt with through a more direct focus on transformations in the actions of the main actors. The outcomes enhance the possibilities of developmental impacts but the relationship is not necessarily a direct one of cause and effect. The outcomes can be logically linked to a project's activities although they are not necessarily directly caused by them. Outcome mapping, therefore, focuses on the contribution of a project in the achievement of outcomes rather than claiming the achievement of developmental impacts.

The development of M&E tools (both qualitative and quantitative) for assessing outcomes and impact on commodity systems, including outcome mapping and participatory impact pathway, was identified as an output target for IITA's Opportunities and Threats Program in 2011 (IITA 2009). This highlights the importance of developing tools not only for documenting technology adoption trends and impact but also those that monitor outcomes, providing stakeholders with timely information about their progress and achievements for systematic and collective learning, reflection, and corrective action.

A few R4D projects at IITA have employed outcome mapping or some of its elements in their M&E framework. For instance, the Consortium for Improving Agriculture-based Livelihood in Central Africa project, largely operating in the East and Central African highlands, follows the spirit of outcome mapping in its arrangements to scale out technology. The boundary partners, comprising international and national NGOs and farmers' associations, articulate their goals, expectations, and contributions through informal or formal memoranda of agreement with the project. The project endeavors to meet the partners' expectations through jointly planned activities to achieve the expected outcomes, which have prospects of producing sustainable impacts. Opportunities for interactions between a boundary partner and the project and among the boundary partners are made available for collective learning, to evaluate progress towards the achievement of goals over time, and to identify corrective measures.

Other CGIAR centers, particularly the International Center for Tropical

Agriculture (CIAT), International Livestock Research Institute (ILRI), and the World Agroforestry Centre, apply outcome mapping in their natural resource management and livestock projects.

Stages of outcome mapping and monitoring tools

The process is divided into three stages. The first, referred to as the intentional design phase, is largely a planning stage. This helps a project to establish a consensus on the macro-level changes it will help to bring about and to plan the strategies it will use. It is based on the principle of participation and purposefully includes those implementing the project in the design and data collection so as to encourage ownership and use of the findings. It involves articulation of the vision and mission of the project, the identification of the boundary partners, the outcome challenges, progress markers, and strategies to be employed for changing the behavior of boundary partners to better deliver the progress markers. Supportive strategies facilitate change, possibly by one partner providing information, capacity, or skills to others.

The second stage is outcome and performance monitoring. It provides a framework for an ongoing monitoring of the projects' actions and the boundary partners' progress toward the achievement of outcomes. It is largely based on a systematized self-assessment and uses monitoring tools for elements identified in the design stage. The tools include an outcome journal (for monitoring progress markers), a strategy journal (for monitoring the strategy maps) and a performance journal (for monitoring the organizational practices).

The third stage is evaluation planning. It helps the project to identify evaluation priorities and develop an evaluation plan (this targets priority areas for detailed evaluation studies).

Strengths and weaknesses

Outcome mapping provides a focus on institutional transformation that is often lacking in techniques which emphasize the delivery of outputs as an indicator of achievement. It aligns itself with the realities of development, often occurring in complex and open systems with multiple actors. The methodology ensures the clear formulation of responsibilities, roles, and progress markers for each project partner in addition to providing a framework and the tools for continuous monitoring. Measurable outcomes and clear milestones enhance ownership by the local actors and beneficiaries as well as the management of multiple accountabilities (project, beneficiaries, partners, and donors).

Outcome mapping's one-dimensional focus on "changes in behavior", although important to sustainable development, cannot be an end in itself for development. The behavioral changes should support improvements in situations at a higher level. There is a need to have clear hypotheses about the framework, tools, and indicators for impact at the level of development results (such as the MDGs). Roduner et al. (2008) have proposed a synthesized model combining the strengths of outcome mapping focusing on capacity building and the logical framework with its focus on development results. The synthesized model has, however, not yet been tested.

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IITA's new social science research agenda

Social science research is one of the major disciplinary areas supporting innovation processes at IITA for achieving a sustainable reduction in food security and poverty in sub-Saharan Africa. As a core instrument targeting the poor, agricultural research requires a social science context to ensure its relevance in the processes of discovery, adaptation, adoption, and diffusion of new technologies, policies, and institutions. Understanding and overcoming the challenges facing the poor in sub-Saharan Africa is important in achieving greater impacts through agricultural research.

Objectives

The new social science agenda in IITA aims to contribute to the Institute's goal of lifting 20–25 million out of poverty in Africa by 2020 through the following:

- Gender-disaggregated agricultural research priorities defined through *ex ante* analyses of impact and commodity situation and outlook
- Improved understanding of the social, cultural, gender, and economic dynamics and determinants of agricultural transformation, rural livelihood strategies, and pathways out of poverty
- Improved understanding of gender-differentiated end-user preferences and the extent, determinants, and pathways of adoption of technological innovations for guiding technology development and delivery efforts
- Alternative institutional arrangements and policy options relating to technology delivery, input supply, and output markets identified and

Social science research at IITA aims to help lift 20–25 million out of poverty by 2015. Photo by IITA.

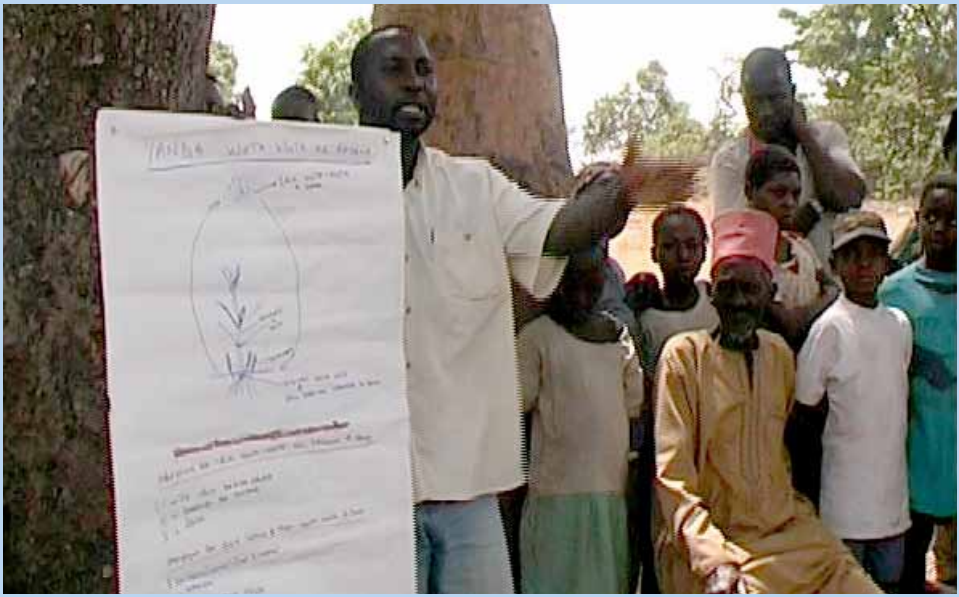
advocated for increased market participation and commercialization among the poor and the marginalized.

Focus of the new agenda

First, social science research establishes a strong knowledge base through geospatial analysis and studies of strategic impact and commodity outlook. All these contribute to an increased understanding of the drivers of agricultural transformation and the role of agricultural technology. These guide investments in agricultural research and complementary public goods for agricultural growth and poverty reduction. For example, smallholder production and marketing constraints and opportunities vary according to existing agroecological and socioeconomic circumstances. Thus, descriptions of smallholders' production systems and analysis of critical production constraints and opportunities, with an assessment of the prospects of alternative investments and technological solutions, are important instruments for priority setting and targeting of research investments for the increased effectiveness of agricultural research and an improved impact.

Secondly, social science research generates knowledge on end-user technology preferences through on-farm participatory evaluation—involving farmers, traders, and processors—and consumer preference studies and market demand analyses. Social science research also assesses early adoption and the impacts of technologies to track the pathways and extent of adoption, to measure adopter-level gains in yield and income, and to identify the socioeconomic, infrastructural, institutional, and policy factors promoting or hindering the adoption of technology. Efforts aimed at raising the productivity and incomes of smallholder farmers involve developing technologies that address key production constraints and have the traits that are preferred by various end-users.

Several social, economic, institutional, policy, and infrastructural factors may hinder the uptake of profitable



A researcher conducting a training for farmers. Photo from SP-IPM.

technologies. Addressing the priorities and constraints facing smallholder farmers and other actors along the value chain is the necessary condition for greater technology uptake and impacts. On the other hand, early adoption studies documenting the extent and determinants—such as socioeconomic and institutional factors—of the uptake of IITA's technologies and adopter-level productivity and income gains provide important information, not only for evaluating the adoption potential of new technologies but also for enhancing adoption and impacts through improved policies and institutions. Not only are there gender differentials in technology adoption but technology adoption may also have differential effects within and across households, due to the influence of social structures, and gender imbalances in access to productive assets and support services.

Thirdly, social science research identifies alternative institutional arrangements and policy options for improved technology delivery, input supply, and output markets with a view to enhancing smallholders' income gains through increased market participation and commercialization with significant feedback effects on technology adoption. Here, niche markets and other high-value product markets are identified and strategies for linking smallholder farmers and entrepreneurs to such markets are promoted. Institutional arrangements and frameworks for enhancing efficiency along input supply and product value chains are identified and promoted.

Fourthly, international research institutes, such as IITA, are confronted with the task of developing prototype technology options and other innovations, usually from specific sites but with an expected applicability to a wider environment for achieving greater impacts. Generic technologies from specific sites must prove successful in their sites of origin but should also indicate high potentials for adaptability in similar areas outside the research sites. The whole issue about the targeting of innovations is to improve our understanding of the processes and strategies that could facilitate the adaptability of generic technologies to a wider environment to achieve significant impact.

Two broad approaches that are complementary for achieving impact are considered: the "geographic" targeting and the "social" scaling of innovations. The geographic targeting applies GIS, GPS, and remote sensing tools to define recommendation domains through aggregating information to higher spatial levels. The social scaling considers the scale-dependency of organizational and policy parameters; it refers to the transfer of the appropriate knowledge to each organizational level through a better understanding of the social and policy processes involved in the adoption and adaptation of innovations.

Fifthly, social science research measures the long-range impacts of IITA's research investments on food and nutrition security and poverty reduction, thus demonstrating accountability to donors as well as providing feedback to the research process. With improved targeting of technology development and delivery, the benefits of social science research are thus realized through increased adoption and impacts of the products of IITA's research.

Social science research at IITA recognizes the role of sociocultural influences on differential gender rights, roles, and privileges, which provides insights into the most appropriate pro-poor interventions beneficial to both men and women. With the recognition that agricultural research and development interventions affect men and women differently, social science research at IITA will contribute to an increased understanding of gender

imbalances in access to assets and the determinants of technology, and market participation. The purpose of this line of research will be to ensure that technology development and delivery systems and commercialization strategies are inclusive of gender issues with a view to achieving gender-equitable impacts of agricultural research with improved benefits to women and the marginalized groups in rural areas.

Apart from the major efforts aimed at mainstreaming and integrating gender issues into much of the social science research agenda, targeted gender analysis will be conducted on the roles, livelihood strategies, constraints, and preferences of men and women, the youth, and marginalized groups in different sociocultural systems. This will help to identify gender-differentiated technology needs, choices, and constraints, and test mechanisms that enhance technology targeting, delivery, and equitable access for greater impact on both men and women.

The social science research agenda contributes to IITA's 10-year strategy for 2011–2020 that has the goal of moving 20–25 million people out of poverty. The formulation of the social science research agenda also takes into consideration the new CGIAR Research Programs (CRPs), particularly those programs in which IITA is involved. It also incorporates findings from the 2009 Stripe Review of Social Sciences in the CGIAR.

Note: The Social Science Working Group was composed of V.M. Manyong (v.manyong@cgiar.org), A.D. Alene, T. Abdoulaye, J. Rusike, E. Ouma, M. Yade, O. Coulibaly, J. Gockowski, A. Tegbaru, and H. Kirscht.

Researcher explaining the concept of biocontrol to farmers. Photo by IITA.

A 10-year strategy for the banana sector in Africa

The Banana 2008 Conference held in Mombasa, Kenya, provided the opportunity for developing a strategy to help propel the banana industry as an important engine of growth in Africa.

It was attended by more than 300 participants from the research and development arena, the private sector, and the business development, production and processing, policymaking, and marketing sectors.

Identifying priorities
The week-long conference focused on the themes markets and trade, production, and innovation systems. Within each theme, subthemes were identified along the whole commodity chain.

The participants identified priorities under the themes that cover the three banana types (dessert banana, plantain, and East African highland banana or EAHB) at three market levels: local, regional, and international.

The table on the next page shows the priorities identified by participants for each banana type and market level.

From priorities to action
Priority setting was the first step in strategy development. The next step was identifying who needs to do what to achieve these priorities.

Improving linkages
Improving linkages across the value chain is urgent if the banana sector is to be transformed. Better linkages, which depend on improved information provision and communication between actors, are important in achieving many of the identified priorities. Within markets and trade, for example, the successful matching of supply and demand depends to a large extent on an information flow through effective linkages.

Similarly for production, improved linkages are critical to solve the current gap between science and practice, and allow farmers to have access to knowledge so that they can address production constraints.

All stakeholders must recognize their responsibility to nurture synergistic relationships along the commodity chain. Principal actors (growers, traders, agribusiness, processors, retailers, and consumers) must be open to sharing information with other stakeholders. Supporting actors (those who

Banana is an important food in West Africa. Photo by IITA.

Priorities for the banana sector in Africa, by banana type and market level.

● = where every group (of 8 people) selected an issue as one of their key three priorities; φ = where more than 50% of groups selected the same priority; and o = if less than 50% of groups (but more than 0%). None highlighted a priority. Loc = local market, Reg = regional market, Int = international market

Priorities	Banana type and market level								
	East African Highland banana			Plantain			Dessert		
	Loc	Reg	Int	Loc	Reg	Int	Loc	Reg	Int
Markets and trade									
Match supply and demand	●	●	●					●	o
Recognize consumer preferences	o	o	o	●	●	●			
Stabilize raw material inputs for processing				●	●	●			
Tailor technologies to scale and level of industry					φ	φ	o	o	
Develop business plan (including models and policy)							φ	●	φ
Growers select most suitable market type	o	o	o				o		
Involve market representatives throughout the value chain	o	o	o						
Liberalize trade (agreements)						o	o	o	
Improve input supply systems				o	o	o			
Match exports with regional needs					o	o			
Production									
Disease-free planting material (micro- and macro-propagated)	●	●	φ	●	●	●			
Rapid and reliable disease diagnostics	o	o	o	φ	φ		o	φ	
Methods for pest and disease control	o	o	o	o			●	●	
Ecological durability of intensified cultivation systems	o	o		φ	φ	φ	o	o	
Genetic improvement of available varieties			o	φ	φ	φ			
Phytosanitary standards developed and regulated				φ	φ	φ			
Reduction in postharvest losses	o						●	φ	
Ripening technologies							o	o	
Innovation systems									
Linkages with agricultural research for concerted action, impact evaluation, and feedback	●	●	●	●	●	●			
Information services to farmers and results communicated to researchers	φ	φ		φ			●	φ	φ
Mechanisms for small farm sectors to influence research and policy					φ	φ		φ	
Reward and train research and development actors to increase the efficiency of impact pathways				φ	φ	φ			
Effective organizations and infrastructural linkages		φ						o	

provide services, inputs, and technologies) and those determining the operating environment (Governments and subregional trade organizations) have a key role to play in initiating and promoting new ways of working that encourage stronger linkages. Extension services provide a particularly important link in the banana chain and need to be strengthened—a role and responsibility of Governments.

To improve linkages across regions, participants suggested creating "knowledge platforms" to share current knowledge and to facilitate multisite testing, training, and education with farmers' groups. Regional systems would feed into a pan-African system for consultative priority setting that is charged with exchanging information, strengthening capacity, forging partnerships, and developing policy to support banana production and trade across the continent.

Empowering farmers
The banana sector will be successfully transformed only if infrastructure is improved and the position of producers is strengthened. Farmers are greatly empowered by working together in cooperatives or farmers' associations. Such farmers are in a much better position to address production constraints and to respond to markets. Information sharing and training are greatly facilitated, and effective innovation systems can develop more easily as the economy of scale is increased from individuals to organizations. Supporting actors, such as NGOs and community based organizations, have a crucial role in promoting the development of farmers' groups. It is also in the interest of agribusinesses to support their creation and operation as it is more efficient and therefore financially viable for them to work with groups for example, in the supply of inputs and purchase of greater volumes of products.

Production
Better linkages and farmers' organizations will greatly facilitate the optimization of production practices, and also help to guide research priorities. Key actors who work with farmers in addressing production priorities are those providing technical services, particularly the extension services, and those working to develop new technologies and stimulate innovation, particularly NARS and the international research community. Actors determining the policy and operating environments also have a role in facilitating access to technologies and services. Banana genetic resources support production systems. Collecting, characterizing, and sharing banana germplasm will require the continuing efforts of the international agricultural research centers, NARS, advanced research institutes, and regional research organizations and networks.

Markets and trade
Again, effective linkages and participation in farmers' organizations are needed to enhance farmers' abilities to understand and respond to markets at all levels. However, markets are rapidly changing, and responding effectively and appropriately will be a major challenge across the banana chain.

At the local and regional level, expanding urban markets and the flourishing supermarket sector will offer many opportunities for banana growers and traders. Improved transport and market infrastructure, provided by local and national governments, is critical to stimulating growth in this area. Processing into innovative and durable new products will become more important to reach more distant regional markets and to smooth out seasonal discrepancies in supply and demand. Agribusinesses and regional trade organizations can guide interventions, with support from governments. Market information will be critical; the need to share this information will bring in actors in the

communications field, such as the providers of mobile phone networks.

At the international level the dessert banana will continue to dominate trade, but changes in European trade tariffs will mean that production and freight systems in Africa will need to become far more competitive. There may be opportunities for well-organized farmers' groups, for example, in supplying "fair trade" and similarly certified bananas. The main actors include international traders, airlines and shipping companies, supermarkets, standard-setting and certification organizations, governments, and regional and international trade organizations. Inland production areas are seriously disadvantaged with regard to transport costs and will require creative market opportunities, such as value-added processing.

Promoting innovation
Effective linkages are at the heart of successful innovation systems.

The Agricultural Science, Technology and Innovation (ASTI) system was adopted as the take-off point for promoting innovation.

In this model, effective linkages and empowered farmers were recognized as holding the key to innovation in the banana sector. Information and communication pathways are also fundamental. There is potential for innovation in all relationships across the banana chain, with all principal actors involved. Those who focus on supplying new technologies and promoting innovation are particularly important, specifically research organizations at all levels (national, regional, and international). The private sector also has a crucial role in facilitating innovation as a source of new technologies and also as a conduit for transferring technologies that may be familiar in a different context to a new set of banana producers or marketers.

Implementing the strategy
The Forum for Agricultural Research in Africa (FARA) and its various elements will be pivotal to transforming Africa's banana sector. The framework of FARA is the Comprehensive Africa

Banana being transported by truck to city centers, Uganda. Photo by IITA.

Agriculture Development Programme (CAADP) which has four pillars. Pillar IV aims to enhance agricultural research, technology dissemination and adoption, and its implementation is governed by the Framework for African Agricultural Productivity. The goals are to integrate natural resource management, encourage adoption of appropriate germplasm, develop sustainable market chains, and stimulate policies for sustainable agriculture. The banana strategy addresses these goals specifically for the banana sector, and thus fits squarely into the mandate of FARA.

Implementation of the strategy will begin by building an informed knowledge base organized around innovation platforms that both involve stakeholders and encourage ownership. Implementation of the strategy can happen under existing institutional arrangements. For research issues, NARS join into the subregional organizations such as West and Central African Council for Agricultural Research and Development (WECARD), Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA), and the Southern African Development Community. For trade issues the key bodies are the Economic Community of West African States (ECOWAS)

and the Common Market for Eastern and Southern Africa (COMESA). All of these, in turn, feed into FARA. Technical backstopping and technology validation at the regional level will be facilitated by the research centers of the CGIAR and their numerous and diverse research partners, both within Africa and outside the continent. Additional support in specific areas will come from the Technical Centre for Agricultural and Rural Cooperation and the African Agricultural Technology Foundation.

Banana researchers in Africa have been accustomed to collaborating within regional networks: Réseau Musa pour l'Afrique Centrale et Occidentale is a part of WECARD and the Banana Research Network for Eastern and Southern Africa is under the auspices of ASARECA. These networks have recently been widened to include NGOs and private sector participants. Links to banana researchers in other regions, for the exchange of information and technologies and for collaborative problem-solving research, are promoted through the global ProMusa network, which also constitutes the Banana and Plantain Section of the International Society for Horticultural Sciences.

Innovation platforms are now envisaged that will unite researchers, extension agents, farmers and farmers' organizations, agribusiness staff, traders, policymakers, and development partners. Research priorities and technology dissemination strategies will need to be market-oriented and participatory, and use approaches such as collective action by farmers, farmer-to-farmer learning, market-led technology adoption, and mutual learning in the market chain.

The strategy for transforming the banana sector in Africa fits precisely in the FARA model for agricultural innovation and economic development, and can be implemented under existing institutional arrangements. Participants believe that this would facilitate increased visibility and the mobilization of the breadth of expertise and depth of resources needed for its successful implementation. Such an outcome could indeed help banana to realize its full potential as a major economic driver for sustainable and equitable development in Africa.

Who's who

Hartmann:
Social science is crucial

On 31 October 2011, Dr Hartmann completes his tenure as the sixth Director General of IITA. In this interview with Godwin Atser, Hartmann shares his experience in his 10-year stay at IITA.

What motivated you to go into international research?
I have to go far to answer that question. I grew up in a very, very poor home where my parents had to worry about how to feed us tomorrow. I think that had something to do with it. So when I was at the University of Florida as a professor, I was teaching development economics. But this was simply about theoretical models. The challenge for us to do something real solid on the ground was really itching in my head. When the opportunities came, I always went for them. I worked in Cuba, Panama, Nicaragua, Cameroon, and Malawi, among other places. And then I not only found enjoyment doing what I was doing but also a lot of satisfaction from doing the real things that I was teaching in theory. It also helped fulfill a hidden desire to help those who were as I used to be.

How has it been working for IITA this past 10 years?
To put it very simply, it has been the best job of my life. I always try to transform myself, so I never want to stay on one job forever. I have had several jobs, but this one has been the best. I could not have designed a more fulfilling job.

What has been your experience at IITA?
I came to IITA and I never knew about the CGIAR systems in institutions of this kind. It was a fantastic surprise to find the kind of people I found in IITA. Looking back, I would say that the biggest, most beautiful surprise since I got to IITA is the dedication of staff here; I have never seen people so dedicated. Staff give almost their all. They put in a lot of long hours; we work most weekends with staff and they are not paid overtime. So, I think they just believe in what they are doing, and this is the most beautiful thing that any administration could ever want. Three years ago, we did a survey of the scientists. All of them said they enjoyed working for IITA because it gives meaning to their lives. I found that the most satisfying input. When you have that kind of people, everything is possible.

What are some of the major changes that you have made in IITA?
Well, I was quite lucky, I think, because unlike some places where a Director

General leaves and a new one comes to demolish things and rebuild things in a different way, I was lucky and appreciative that my predecessor had done a good job, and so I did not have to demolish much, actually, anything. I had to build on what he left. So that was very productive.

One thing that I hope that we've achieved is to put IITA on a most stable footing. The second thing is, and this is to credit most of the scientists and the administrators and people like DDG-R4D Paula Bramel, the R4D focus that we brought. Now all the scientists think that way. We had an external review last year and when the head of that review was leaving, he called me aside and asked, "What did you do here?" I said, "What do you mean?" He said, "We tried to do this R4D thing in Australia and it was only at the level of the senior administrators," but the way he had found it here, it permeated all levels, whether it is in the official questions or the unofficial questions scientists talked about. For this success I credit the R4D group. That is very important because it really shapes how the institute behaves and how it focuses; it never takes its eye off the poor.

If you were to start over, what would you do differently?

I wouldn't do anything differently. I would accelerate some things because we'd predicted in 2002 the changing environment we are now in but what I did not predict was the speed with which the CGIAR would change. And so I would do some things faster. I would move to constructing the hubs more quickly. I would consolidate staff much faster than we have been doing. We tried to do it in a way that would not disrupt the "nice" pace, but the CGIAR changed abruptly in a very different way. So, I would not change the strategies we put in place in 2002 but I would accelerate the speed at which we worked.

In what area has IITA contributed the most?

I think IITA's biggest contribution has been in the area of food productivity, the combination of helping farmers produce more with better varieties, like the soybean story. Many countries are now producing much better than they did before.

Nobody else has the capacity to deal with biological threats because it requires being able to work across borders. National systems, no matter how good they are, cannot work across borders. It is harder for them. IITA can do that easily.

So we really have powerful and helpful capacity. If you bring these two together—dealing with biological threats and improving the productivity of crops—I think that is what IITA has been able to contribute.

What needs to be done to strengthen those areas where you feel IITA is not as strong as it should be?

You are being very diplomatic. You should have asked "What is IITA's weakness?"

No matter how good you are in your profession you always look for ways to improve and must even be your own hardest critic. In IITA, there are very clear areas where we are weak and we need to strengthen them. In the old days, the CGIAR groups of donors funded us 100%. Now they only fund about one-third, so IITA must find the other two-thirds. The intelligence of knowing where donors are going is weak; the ability is weak to respond to donors when they need something; we don't have good capacity in making bidding proposals and enough success in winning proposals and that is an area where we really need to work. We need people to be sensitive in each country about how our donors are thinking, changing; where they are going; and then we need a capacity to put this

together into winning proposals. The competition is cut-throat and we would not be given any project or funding just because we say we are good. We have to produce good proposals. While we have good people, we can produce the good science. The ability to put it all together in a cohesive competitive proposal is still inadequate in IITA.

This issue of R4D Review is focused on social science and IITA's impact. How do you see the performance of the social science group in IITA?

The social science group in IITA is crucial, because it is really the broom that brings things together and makes them work to the benefit of the people you want to help.

When IITA started, the emphasis was mostly on the breeding program, which was fine at that time. We were expected simply to produce better plants but more and more the poor and donors were getting frustrated; they wanted to see impact on the ground and you cannot get impact if you don't understand how things work. For example, when we introduced soybean in Nigeria, IITA was a laughing stock. Nobody expected that Nigerians would be consuming so much soybean, but the IITA staff, being very sensitive, worked on the social dimensions of soybean—not on producing new varieties alone. They looked at what Nigerians ate, how they cooked their food, etc. Today those doubting people are not laughing at IITA any longer and Nigeria has become the largest producer of soybean in Africa. This is social science… so social science is a vital dimension to our biological science.

Most times you wear a hat. Is there a special reason?

(Laughs) I was once interviewed here by the BBC and they asked me if I always wear a hat and I said, yes, even in the shower. I don't know…when I came to Nigeria my daughter looked at different albums from her grandparents and collected pictures of me from my youth and made a collage. As we were putting it in the house, we noticed, to our surprise, that I had been putting on a hat since I was a kid. I don't know what brought it about but it seems to be a habit; I was just not aware of it at the time.

Some people like to wear certain clothes or suits or ties, or some guys will never go to work without a tie. I don't go to work without my hat.

IITA's biggest contribution is in the area of food productivity, according to Hartmann.
Photo by IITA.

Akin Adesina: Making agriculture work for farmers

Nigeria's Minister of Agriculture and Rural Development, Dr Akin Adesina, talks about his strategy for a Green Revolution in Nigeria and his life's mission of helping farmers.

Sir, you have a tall order for yourself and for the Ministry in particular. Could you tell us your program priorities?

The tall order is not one that I actually set. The tall order was set by the people of Nigeria in terms of expectations from the political class. When President Goodluck Ebele Jonathan was endorsed by the people in a huge way, he told Nigerians, "I will never, never let Nigerians down." That is the order.

So my task as Minister of Agriculture is derived from the President's commitment to Nigerians. I have to make sure that Nigeria's agriculture delivers in such a way that we can feed Nigerians; that we put a lot of the youth to work; that we can reduce our import dependency; that we can get a new generation of young farmers back into agriculture; that we can diversify the economy from relying just on petroleum; that we can get our crops—cocoa, oil palm, and cotton—competitive and back into the market. My task is to make sure that Nigeria can feed itself with pride and to make sure that Nigeria does not become a dumping ground for food; we should be a net exporter of food.

In practical terms, how will you achieve this?

If you want to rebuild a house, you first figure out what's wrong with the house before you start putting your structures in place. Nigeria used to be the largest player in palm oil. We were producing 60% of the global production; today, zero. We used to account for 30% of cotton production, just like groundnut; today, we are almost near zero… And so my task is, first and foremost, to bring a new sense of order to the disorder in the agricultural sector.

Today, we must rapidly raise productivity; make improved seeds, hybrids, and fertilizers available to farmers; make sure they have access to finance; and improve their access, so they can actually begin to produce a lot of food for the domestic markets.

The second thing that we have done is to launch the Cassava Green Revolution. As you know, Nigeria produces 45 million t of cassava; we are the largest producer in the world, but we account for 0% in terms of global value addition. For our Cassava Green Revolution, we

want our farmers to make money, and they'll be getting better markets when their cassava is actually processed, for example, as starch, ethanol, glucose, chips for livestock feed and, of course, *gari*.

We have also launched a Green Revolution for sorghum and a Green Revolution for sweetpotato, because sweetpotato, especially the orange-fleshed kind, allows us to add beta-carotene for kids.

In terms of cash crops, we are looking at cocoa and oil palm.

What has been the response of the private sector? How do you intend to bring them into your strategy?
The private sector is the engine of growth. Every time you unlock the power of the private sector, you will create a lot of jobs and have significant amounts of growth. Agriculture is a business, so we need the private sector in the seed set-up. For example, in this country we have about 11 seed companies that are functional. Those seed companies need access to financing to be able to expand their production from the current level of about 5000 t to a million t. That means that they must have access to land and financing—for processing and seed-processing equipment—long-term investment, not just working capital. And so, the Ministry is putting together a venture capital fund that will enable our seed companies to get access to the financing that they need.

What role could partners such as IITA and NGOs play in your strategy?
First and foremost, I cut my teeth in research, actually working for the CGIAR. I also worked in IITA in the 1990s. I am enormously proud of IITA, of what it does, and its impact on Nigeria and all of Africa. Why are the international agricultural research centers (IARCs) such an important system? There's a history to that. When the Green Revolution started in Asia, it happened because the International Wheat and Maize Improvement Center (CIMMYT) in Mexico and the International Rice Research Institute (IRRI) in the Philippines worked on new varieties of wheat and rice that rapidly increased farmers' yields by three or four times.

The Nigerian Green Revolution in cassava has started. Photo by IITA.

That particular situation lifted a billion people out of poverty in Asia. The basis of that was the IARCs. In Africa, the prime center of the system is IITA. IITA has done well. There was a time when we had a problem with the cassava mealybug that was destroying cassava all over Africa. IITA helped to develop a biocontrol program that dealt with it and with a billion dollars worth of benefits. In fact, it is probably the best research ever in the world in terms of biocontrol for any given thing when it comes to rate of return.

IITA was behind the Maize Revolution in the northern Guinea savanna of Nigeria in the 1980s. IITA released new varieties of maize that turned the entire northern Guinea savanna from relying on sorghum to producing maize as a cash crop.

Let's look at IITA and soybean. Nigeria never used to grow soybean; we were importing it. The Nigerian Government supported IITA then; some people said we shouldn't. In fact, some foreign Governments said, "If you support IITA, we would not fund IITA any longer." The Nigerians said, "No, we will support IITA" and they did. IITA then released the TGx varieties in the northern Guinea savanna. Today, Nigeria is the largest producer of soybean in Africa. IITA also continues to work on developing better, high-yielding varieties of maize and soybean. In addition, IITA is working on aflasafe™ which is dealing with the huge problem of aflatoxin contamination in the north.

This shows that one cannot get far without research. It's not just IITA; we have other IARCs here, such as AfricaRice, CIMMYT, International Center for Research in the Semi-arid Tropics (ICRISAT), and the International Livestock Research Institute (ILRI), all working in Nigeria and all in their own way having significant impact. I believe that for us to achieve the Green Revolution, IITA and other organizations have to put more effort in pushing out appropriate technologies to farmers. There has to be better coordination and synergy between the IARCs and our national institutes. When India achieved its Green Revolution, most of the people who did the work were from the Indian Agricultural Research Council. For Nigeria, we want our national agricultural research centers strengthened so as to be level partners with IITA.

At the end of the day, we have to make sure that there is R4D, research for development, not research for research. IITA and other centers are pioneering this area, making sure that agricultural research is relevant to the needs of the end user.

If you look at investment in agricultural research, it has the highest rate of return of anything—higher than that from health and education. If you can just increase the productivity of agriculture in Nigeria by 10%, you can lift 70 million people out of poverty. Obviously, that requires investment in research. My own desire is that the donors that are supporting IITA continue to support IITA and other IARCs still more because we need them for our Green Revolution.

But in addition, our Government also needs to look at the amount of money we are spending on agriculture compared to what was agreed at the NEPAD—countries were to put 10% of their budget into agriculture. If we are at 3% and less, we need to change that and be able to come back to 10%. Mali, Niger, Burkina Faso, Malawi, Kenya, and Ethiopia are all at 10% and more, and we have more mouths to feed than they have. So, we can't just simply say we are relying on external institutions; we must have sufficient resources to drive the agriculture change process. Also, domestically, research pays off enormously.

As a former member of staff in IITA, what are the areas you think need to be strengthened?

IITA must ensure that its available technologies such as cassava varieties that give 40—50 t/ha reach farmers.

Secondly, IITA needs to get back into what it used to do before: training national scientists, providing them with opportunities to come in and spend sabbaticals at IITA. At the end of the day, it is the national institutions that will have to deliver the change, but you need strong national partners to work with.

The other thing that I think is crucial for IITA is to work more on markets. It needs to make sure that the value-chains for commodities such as maize or cassava really work. I really admire what DG Hartmann has done in that area. He's putting the focus on markets. This is very important and I hope IITA will continue to do more of that.

Finally IITA needs to look at policy. When the Green Revolution happened in Asia, there were policies that drove the changes. The CG centers did not just leave the varieties there; they pushed and drove the necessary changes. So, there needs to be strong policy advocacy from IITA and other centers to help farmers have access to seeds, fertilizers, markets, and infrastructure. In the case of technology, don't just produce technology and assume that, somehow, the technology will find its way to the farmer's field. Stick with it, work with the Ministry of Agriculture; work with Government to make sure that the technology actually is in the farmer's field and that it works.

Agriculture is not just about food, says Minister Adesina. Photo by IITA.

Who is your role model?

I have two role models. My first role model is my father, who was a farmer. In those days, he used to work on people's farms as a laborer with my grandfather. After days of hard work and at the age of 14, my father couldn't read and write. He said agriculture wasn't paying for him to go to school. Fortunately a Good Samaritan came around and saw him on the farm and took him to Lagos. That's how my father was educated and eventually became a Government Auditor. That's the only reason why you are interviewing me now; it's because somebody sent my father to school.

My father told me that there are so many people who had missed opportunities in life just because agriculture was not working for them. So he taught me very early in life that if I ever found myself in a position to make a difference, especially for farmers, I should make sure agriculture would work for them. He said agriculture was not just about food; it's about creating wealth for farmers, providing an income to send their kids to school and have a better life. And that has always been the guiding light in my profession: making sure that agriculture works for millions of poor farmers.

My second role model is Dr Norman Borlaug, the father of the Green Revolution in Asia, who inspired me so much. I believe in all that I do. I am driven by the fact that one day, I'll give an account to God for the responsibilities and opportunities given me to change the lives of people. So it's not just academic work; it's a life mission for me, to make sure that agriculture works to transform the lives of our people. So in between my father teaching me the right values and Dr Borlaug showing me that it can be done, I have a very tall order to fill indeed.

IITA R4D Review

The IITA R4D Review is published by IITA, Africa's leading research partner in finding solutions for hunger and poverty.

Issue 7, September 2011

The IITA R4D Review is a six-monthly magazine intended to help IITA and research and development partners, investors, collaborators, and beneficiaries discuss and develop the best new ideas for people creating, leading, and transforming tropical agriculture.

The R4D Review has six sections:

Features provides an in-depth, rigorous presentation of a significant advance in research-for-development thinking and its application to real world needs that help establish an intellectual agenda for discussion—and change—within the organizations and for society at large.

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Looking In features people from outside IITA whose ideas hold salient lessons for those within IITA.

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CONTRIBUTIONS needed

The R4D Review is looking for new sources of solid, useful ideas that can improve research-for-development practice. Please send your contributions or participate in the discussions in the R4D Review interactive site at www.r4dreview.org. The general guidelines for contributions are also available at this site. Prospective authors can also send submissions, communications, comments, and suggestions to: The Editor, R4D Review.

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