

A REPORT OF THE CSIS GLOBAL  
FOOD SECURITY PROJECT

# Strategic Partnerships to Build African Scientific Capacity for Agriculture

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CSIS | CENTER FOR STRATEGIC &  
INTERNATIONAL STUDIES

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ISBN 978-0-89206-694-0

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## ACKNOWLEDGMENTS

This project grew out of CSIS's recognition of the importance of agricultural development in U.S. foreign policy and development assistance. Our analysis was conducted with the generous financial and intellectual support of the Richard Lounsbery Foundation and Max Angerholzer, executive director, who have championed the importance of scientific diplomacy. In our collaboration, we recognized that, in the context of U.S.-African relations, agriculture is a natural and important focus for increased and improved scientific exchange. The project has also received support from the Bill & Melinda Gates Foundation.

This project and report benefited greatly from a community of agricultural development and extension specialists, and we have received tremendous insights from our speakers: Dr. Ousmane Badiane, director, Africa, International Food Policy Research Institute (IFPRI); Dr. Roger Beachy, director, National Institute of Food and Agriculture (NIFA), U.S. Department of Agriculture (USDA); Dr. Samuel Kyamanywa, dean of the School of Agriculture, Makerere University, Kampala, Uganda, and site coordinator of the Integrated Pest Management (IMP) of the Collaborative Research Support Program, or CRSP, in Uganda; Dr. Eugene Terry, senior technical adviser, TransFarm Africa, and board member of the World Vegetable Centre (AVDRC), the Syngenta Foundation for Sustainable Agriculture (SFSA), and the West Africa Centre for Crop Improvement (WACCI), as well as founding director of the African Agricultural Technology Foundation (AATF); and Dr. Emily Twinamasiko, director of research coordination, National Agricultural Research Council Secretariat in Uganda, and executive advisory board member of the Water Efficient Maize for Africa (WEMA). Their wide breadth of experiences and backgrounds gave us a much greater understanding of the challenges and opportunities in agricultural science, which is reflected in our recommendations.

At CSIS, Richard Downie, Kristin Wedding, Anna Applefield, and Farha Tahir all contributed substantially to the project and report. We greatly appreciate the feedback received from several participants in our working groups, many thoughtful experts at the U.S. Agency for International Development (USAID), and a range of other institutions, including the Association of Public Land Grant Universities (APLU) and USDA's Foreign Agriculture Service (FAS).



# STRATEGIC PARTNERSHIPS TO BUILD AFRICAN SCIENTIFIC CAPACITY FOR AGRICULTURE

## Executive Summary

The world faces an enormous challenge over the next 50 years, to double the amount of food produced globally, but without further depleting the soil, water, and other natural resources. This challenge will require a great deal of ingenuity and effort, and will rely on the capacity of the scientific community to develop new and improved crop varieties, to combat pests and diseases. It will require farmers and scientists to make better use of poor soil while addressing droughts, and to communicate about the importance of science and technology in agriculture.

The international agricultural science community has prioritized increasing agricultural productivity, and the result has been a dramatic increase in yields in North America, Latin America, and Asia—especially South Asia and Southeast Asia. These advances have largely passed by Africa. To achieve the level of production and distribution of food needed in 2050, a new emphasis must be placed on raising productivity throughout the world, but especially in Africa, which has abundant resources and potential for growth—growth that is sustainable and protects natural resources. This will require a focused scientific effort; it will require an emphasis not just on productivity enhancements, but also on improved food processing and reduced post-harvest loss; and it will require focused and intense scientific cooperation, communication, and extension (where academics and researchers have direct contact with the farming community). The effort will also require a strong and empowered cadre of African scientists, researchers, and institutions to develop and adapt scientific innovations best suited to the African context and most likely to drive longer-term productivity and development.

The United States has a long history of agricultural scientific cooperation with Africa. There is a legacy, beginning in the 1960s, of exchanges between U.S. universities and African researchers. International cooperation and support of African agricultural institutions and universities have historically been powerful tools to develop research and educational capacity in Africa. U.S. universities—in particular, the land-grant universities—have had long and enduring partnerships with African institutions and scientists. U.S. universities bring their unique approach to applied, practical research, as well as open engagement with farmers through the practice of extension; African universities bring a unique set of researchers, energy, and ideas and challenges for collaborative work. However, along with support for agricultural development, support for scientific exchanges and higher education has waned over the past 20 years. But new capabilities and technologies have been introduced, creating new opportunities for scientific cooperation.

Although the value of international research and training collaboration is compelling, recent evidence shows that graduate-level training should increasingly occur within Africa. The approach

will balance and complement valuable training received overseas, will provide experience relevant to the long-term problems of the scientists' home countries, and will build an "ecosystem" of science and research, with the aim of building individual, institutional, and community capacity.<sup>1</sup> Several reasons explain why past models should be redesigned rather than simply reinstated in their old form. Some of the problems associated with traditional long-term training models include a lack of focus on host-country problems, lack of integration into host-country networks of science, high costs of training, and the potential for researchers to remain where they are trained rather than return home to implement their research. Scientists trained in U.S. institutions are generally trained to address problems relevant to U.S. agricultural products and climates, rather than issues that affect agriculture in their home countries. Many students who have gone overseas for graduate education have not returned to their home countries, where opportunities to apply their skills and knowledge are often lacking. Finally, the costs for U.S. training are increasingly prohibitive, as university fees and tuition have risen dramatically. In the past decade, for example, the average cost of an undergraduate degree from a private institution has increased by more than 60 percent, to over \$42,000 annually. Tuition and expenses at public colleges have seen similarly dramatic increases, doubling to \$21,000 for in-state students.<sup>2</sup> Such dramatic increases in cost can make it untenable to sponsor international students for the duration of a degree program at an American institution.

The United States should be proud of its impressive legacy of educational exchanges in Africa, which have helped to build a generation of leading African scientists. It should revitalize this important cooperation in ways that will support and energize a new generation of scientists and researchers to work together on the challenges of feeding a growing population and reducing poverty. The following report provides an overview of agricultural science cooperation within the African research system; the university system; and the role of partnerships with the private sector. The conclusions point to several areas of opportunity for U.S.-African science cooperation moving forward:

- Research must be focused. Key problems and challenges in African climate and soil conditions require focused, in-situ attention, research, and trials; research must be driven by pragmatism and the potential for impact.
- Building long-term indigenous African research capacities should be a consistent and prominent element of U.S.-African partnerships.
- Research should be coordinated across the range of national, sub-regional, and regional institutions, to support individual and institutional capacities; and African universities should be more fully engaged in national agricultural planning.
- Private-sector partnerships should be encouraged to provide experience in advanced research facilities, and to leverage African researcher knowledge of specific research and agricultural challenges.

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1. Carl K. Eicher, "Building African Scientific Capacity in Food and Agriculture," *Review of Business and Economics* 3 (2009): 249.

2. Kim Clark and Penelope Wang, "Stop the Tuition Madness," *Money* 40, no. 8 (2011): 114–22; *Academic Search Premier*, EBSCOhost Electronic Journals Service (EJS), <http://ejournals.ebsco.com/login.asp?bCookiesEnabled=TRUE>, accessed November 17, 2011.

Much work remains, and there are significant opportunities to increase yields in Africa by providing the science and knowledge of food production and processing necessary to reduce poverty for farmers and increase supply for global markets.

## Background

In 2010, CSIS released several reports evaluating challenges to food security. Each report highlighted the importance of scientific research in increasing agricultural productivity and drew attention to the need for enhanced, focused research on staple crops and revitalized partnerships with research centers in developing countries, specifically in Africa. *U.S. Agricultural Research in a Global Food Security Setting* and *Cultivating Global Food Security* noted the need for a larger and more focused public commitment to agricultural research. Additionally, a report entitled *African Perspectives on Genetically Modified Crops: Assessing the Debate in Zambia, Kenya, and South Africa* assessed African attitudes on genetically modified crops and emphasized the need for a robust indigenous science capacity within Africa to inform policy debates and ensure evidence-based agricultural policymaking.

The research, field visits, interviews, and meetings that informed these reports underscored that scientific cooperation on agriculture is important for the United States to achieve its long-term food security, economic, and agricultural development goals. It is an area that was once robust and active, but has lagged considerably over the past three decades. U.S. government and university investments in scientific exchanges between American researchers and African students and scientists were once common, especially among U.S. land-grant universities.<sup>3</sup> These exchanges dwindled as public interest in agricultural development declined and governments and donors reduced funding for tertiary and specialized education exchange programs.

Several reasons account for this decline: With the advent of the Millennium Development Goals at the turn of the century, primary education, rather than higher education, became a priority for many development projects focused on education. Another reason was a concern about “brain drain,” where donors feared that African agricultural scientists who studied in developed countries would stay in the countries where they were educated rather than return home. Although developing human capacity and investing in higher-education programs continues to be a priority, in some cases students could find better job opportunities in countries where they trained, and often found that the research they had done abroad did not apply to their home countries.

Today, renewed efforts are under way within the U.S. government, university system, and international research community to increase food security and improve agricultural productivity. They offer a new opportunity to explore how scientific cooperation between the United States and Africa can be reinvigorated, improved, and focused on fighting the tremendous challenges to both poverty and food production.

The new U.S. Feed the Future program is housed at the United States Agency for International Development (USAID), but works with many U.S. government agencies, including the U.S. De-

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3. A land-grant college or university is an institution that has been designated by its state legislature or Congress to receive unique federal support. National Institute of Food and Agriculture, “About Us: National Institute of Food and Agriculture,” July 21, 2010, [http://www.csrees.usda.gov/qlinks/partners/state\\_partners.html](http://www.csrees.usda.gov/qlinks/partners/state_partners.html).

partment of Agriculture (USDA). The program recognizes the necessity of long-term investment in science and research to improve agricultural productivity. Feed the Future's research strategy prioritizes investments that address production constraints to smallholder farmers from pests, diseases, and environmental factors by focusing on breeding, genetics, intensification, and technology adoption. It also focuses on building and improving production and nutrition, extension services, and research efforts in the priority regions of Africa and Asia.

Similarly, U.S. universities have seen a recent resurgence of calls for renewed and remodeled university research collaborations. USAID and the World Bank, for example, have recently launched a collaborative project to support agricultural programs on higher education in Africa. This program, part of the Feed the Future initiative, is one of several under way within the U.S. government to reinvigorate university collaborations.<sup>4</sup> These universities, especially those in the land-grant system, which house many of the U.S. colleges of agriculture, have a long history of engagement on agriculture with their African counterparts, and have valued the interaction with international universities and students. However, given the need for more home-grown research on Africa's agriculture, as well as financial constraints, they require a different approach.

On the international front, the Consultative Group on International Agriculture Research (CGIAR) is a strategic partnership of donors that support 15 agricultural research centers around the world, with 4 in Africa. CGIAR has been influential in promoting agriculture as a policy issue within the development community. The partnership is currently in the midst of major changes in its approach to agricultural research and will emphasize targeting collaborative research around key staple crops largely consumed in developing countries. Specifically, this reform aims to increase accountability and streamline donor contributions to ensure that projects with the most potential for impact and the most sound research methodology receive funding.<sup>5</sup>

In light of the challenges to global agriculture and the commitments by the United States and the international community to renew emphasis on agriculture research and build scientific capacity within African institutions, CSIS formed a roundtable of U.S. and African scientists. The aim was to discuss how best to promote exchange on agricultural science between U.S. scientists and policymakers and their African counterparts. Specifically, the group engaged the scientific community to recommend policy approaches that complement the scientific research and technological development being conducted in Africa, and to identify what the U.S. government can do to facilitate this cooperation within the context of its current pledges. The goals of the roundtable series were to raise the profile of the agricultural research and development agenda; build support for an enhanced public role in agriculture; and bring scientists together to share ideas around the role of research and development in the U.S.'s food security efforts. Surprisingly, many of the conversations revolved around the benefits of increased coordination and communication, rather than dramatic increases in funding. In the spirit of tight government budgets, the authors of this report focused recommendations primarily on using and improving programs that already exist, rather than significant increases in spending.

The project focused on addressing the following questions:

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4. "Feed the Future: Borlaug 21st Century Leadership Program," accessed November 17, 2011, <http://www.feedthefuture.gov/article/us-announces-feed-future-borlaug-21st-century-leadership-program>.

5. CGIAR, "Who We Are," accessed September 22, 2011, <http://www.cgiar.org/who/index.html>.

- What is the current state of agricultural science and research in Africa, and how can the various research establishments be supported and encouraged to coordinate on priorities and opportunities?
- How can African universities be strengthened in the areas of agriculture and science, and how can they improve their ties with other research centers?
- What role can the private sector play in research partnerships, and how should partnerships be designed in order to provide long-lasting employment opportunities for scientists in Africa?

The research and discussions around these topics were greatly enhanced by the participation of a strong and knowledgeable group of Africanists, agricultural scientists, and policy experts from both the United States and Africa. The group met three times, and in each meeting heard presentations from African scientists. They ranged from East Africa to West Africa, and included plant breeders, pest specialists, and cassava experts. We were also fortunate to have prominent U.S. scientists and policymakers join the discussions. While each person offered a unique perspective, common themes ran through the discussions. The following assessment and recommendations address these themes, along with key areas of opportunity for scientific engagement.

## The Need for Research and Development

For the past decade, the African continent has been experiencing a long and sustained period of economic growth. Both average GDP and agricultural production in Africa have grown by about 6 percent per year. Additionally, productivity growth is spreading across the continent: between 2001 and 2003, just five countries experienced agricultural productivity growth rates of at least 6 percent; by 2005, nine countries achieved this rate of growth.<sup>6</sup> Structural and governance changes, along with increased investments, have improved conditions continent-wide. This growth is likely to continue, but achieving the next phase will be more difficult, as it will require more complex changes such as improved education, communications and technology connections, physical infrastructure, and market development.

Challenges to food security, including changes in weather patterns, major droughts, and increasing population growth, underscore the increased need for focusing on agricultural capacity building in Africa. A tremendous challenge lies ahead for global food security and agricultural production as the world strives to increase food production by 70 percent by 2050 with nearly 20 percent less water and the same amount of arable land to meet the increasing demands of a growing global population.<sup>7</sup> As demand and population increase, smallholders across the developing world will be challenged to increase agricultural productivity, find markets for their products, and improve their overall economic conditions.

From 1950 to 2000, the average farmer in the United States increased his yield by 12 times, and the average yield per acre of corn production increased from 39 bushels to 153 bushels.<sup>8</sup>

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6. Ousmane Badiane, *Sustaining and Accelerating Africa's Agricultural Growth Recovery in the Context of Changing Global Food Prices*, International Food Policy Research Institute, November 2008, <http://www.ifpri.org/sites/default/files/publications/bp009.pdf>.

7. Food and Agriculture Organization of the United Nations (FAO), "How to Feed the World in 2050," [http://www.fao.org/fileadmin/templates/wsfs/docs/expert\\_paper/How\\_to\\_Feed\\_the\\_World\\_in\\_2050.pdf](http://www.fao.org/fileadmin/templates/wsfs/docs/expert_paper/How_to_Feed_the_World_in_2050.pdf).

8. Keith Fuglie, James MacDonald, and Eldon Ball, *Productivity Growth in U.S. Agriculture*, U.S. Department of Agriculture, September 2007, <http://www.ers.usda.gov/publications/EB9/eb9.pdf>.

Productivity has risen as a result of increased use of land, water, fertilizer, pesticides, and—importantly—improved varieties of seeds, made possible through major innovations in crop and animal science. Other continents have been able to harness technology to bring about substantial increases as well. South America, for example, saw an increase in per capita food production of 29 percent.<sup>9</sup> Sub-Saharan Africa, on the other hand, had a slight decrease of 4 percent per capita, and yields in sub-Saharan Africa are still substantially lower than global yields.<sup>10</sup>

Use of technology and improved seeds and inputs is also limited. In Asia, at least 80 percent of the planted crops are new varieties of rice, maize, sorghum, and potatoes. In sub-Saharan Africa, grain yields per acre are roughly 40 percent of those achieved in other developing countries, and only 20 to 40 percent of sub-Saharan Africa's planted crop area uses new seed varieties.<sup>11</sup> On a continent where agriculture is nearly one-third of the economy, and 80 percent of land is managed on 2-hectare plots, agriculture is a key priority for economic development in Africa. Agricultural research and development will continue to be among the most productive investments, with rates of return between 30 and 75 percent. But this critical sector for growth has largely been neglected in many low-income countries.<sup>12</sup>

## U.S. Investments in African Research: A Neglected Legacy

Historically, building scientific capacity has been an important and productive aspect of U.S. engagement in African development. Although in the past few decades this support has waned substantially, it is now experiencing a renewed focus. For example, in 1990 USAID supported 310 students from developing countries to study agriculture at American universities; this decreased to just 82 in the short span of 10 years. USAID sponsored scholarships to African students for overseas postgraduate training in agriculture fell from 250 in 1985 to 42 in 2008.<sup>13</sup> Additionally, in 1985 USAID allocated the largest share of its Africa budget to agriculture (47 percent) and it provided scholarships to 250 Africans for overseas training in agriculture.<sup>14</sup> In 1998, USAID allocated only 10 percent of its Africa budget to agriculture<sup>15</sup> and provided scholarships to around 20 African students for overseas long-term training in agriculture.<sup>16</sup>

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9. Douglas Southgate, "Population Growth, Increases in Agricultural Production and Trends in Food Prices," *Electronic Journal of Sustainable Development* 1, issue 3 (2009), [http://www.ejsd.org/public/journal\\_article/13](http://www.ejsd.org/public/journal_article/13).

10. Ibid.

11. Shenggen Fan, Michael Johnson, Anuja Saukar, and Tsitsi Makombe, *Investing in Agriculture to Halve Poverty by 2015*, International Food Policy Research Institute, February 2008, <http://www.ifpri.org/sites/default/files/publications/ifpridp00751.pdf>.

12. FAO, "How to Feed the World in 2050," [http://www.fao.org/fileadmin/templates/wsfs/docs/expert\\_paper/How\\_to\\_Feed\\_the\\_World\\_in\\_2050.pdf](http://www.fao.org/fileadmin/templates/wsfs/docs/expert_paper/How_to_Feed_the_World_in_2050.pdf).

13. Catherine Bertini and Daniel Glickman, *Renewing American Leadership in the Fight against Global Hunger and Poverty: The Chicago Initiative on Global Agricultural Development*, Chicago Council on Global Affairs, 2009, [http://www.thechicagocouncil.org/UserFiles/File/GlobalAgDevelopment/Report/gadp\\_final\\_report.pdf](http://www.thechicagocouncil.org/UserFiles/File/GlobalAgDevelopment/Report/gadp_final_report.pdf).

14. Carl Eicher, *Institutions and the African Farmer*, CGIAR, September 1999, <http://www.worldbank.org/html/cgiar/publications/issues/issues14.pdf>.

15. Ibid.

16. Ibid.

This long history of scientific cooperation has made important contributions to scientific capacity in African countries and to the lives and careers of American scientists who have participated in exchanges as students and professors. It is commonplace to meet senior African scientists and agricultural experts and find that they have earned at least one degree—often a doctoral degree—from a U.S. university, usually a land-grant university, many of which house the United States’ most innovative agricultural research. Many African senior leaders in this field were trained at schools such as the University of Minnesota, Michigan State, and Purdue University. This includes prominent leaders in African agriculture such as Kanayo Nwanze, president of the International Fund for Agricultural Development,<sup>17</sup> who earned a PhD in agricultural entomology at Kansas State University, and Rwandan agriculture minister Agnes Kalibata, who earned a PhD in entomology at the University of Massachusetts, Amherst.<sup>18</sup>

As U.S. investments in scientific cooperation have waned, the cost of advanced education in the United States has climbed. It may be wise to maintain some full research fellowships, but given the high costs, it is not feasible to return to the previous style of scientific education where students travel to the United States for extended graduate studies. In addition, African scientists trained solely in U.S. institutions are often trained in research areas more relevant to the U.S. state and region where their universities are located, rather than to the challenges of their home country or region. U.S. engagement with African scientists must evolve to suit the current environment. The question is how U.S. resources and efforts can be most fruitfully applied at a time when opportunities are great but resources are few.

## Part 1: What Does African Agricultural Research Look Like Today?

Multiple and diverse challenges to advancing an agricultural science and research agenda will be necessary to transform Africa’s agricultural system, reduce poverty and improve livelihoods, increase productivity, and enhance food security and nutrition. Among the challenges are human capacity gaps; institutional deficiencies in national research programs; the lack of an enabling political environment or national research strategy; underinvestment in funding for research, extension, and education; poor planning and coordination for agricultural research at the national and regional levels; low use of modern technologies; and weak participation from the private sector.

African investments in agriculture and related research have declined over time. Extension systems and outreach to farmers have withered; private-sector investment in African agriculture is weak; and research content is not focused on tackling the long-term challenges of productivity, drought, and climate problems. Agricultural research is not a high priority for many African universities. In part due to a pervasive lack of an enabling environment, the government, rather than the private sector, still conducts the majority of agricultural research. In sub-Saharan Africa in 2000, the public sector employed more than three-quarters of total agricultural research and development staff. In that same year, sub-Saharan Africa accounted for just 0.6 percent of global spending on science and technology, with just 4 percent of those expenditures devoted to agricul-

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17. Kanayo Nwanze, World Economic Forum, accessed September 26, 2011, <http://www.weforum.org/global-agenda-councils/kanayo-nwanze>.

18. University of Massachusetts, Amherst, Department of Plant, Soil, and Insect Sciences, March 2008, <http://www.umass.edu/psis/news/kalibata.html>.

tural development.<sup>19</sup> There is a significant lack of planning and coordination for these efforts at the national and regional levels.<sup>20</sup> Given these formidable challenges, solutions will require creative thinking about new technologies, training and education for farmers, and greater connections between research and application.

African countries have recently sought to address challenges in the agriculture sector through the Comprehensive Africa Agriculture Development Programme (CAADP), under the auspices of the New Partnership for Africa's Development (NEPAD). The CAADP framework provides a useful and important way to organize and develop the agricultural research agenda. The framework's four pillars are land and water management; rural infrastructure and trade; food security/food supply; and agricultural research, technology, and adoption. Planning for CAADP implementation takes place at the national level, and not all research centers are consistently engaged with planning for CAADP goals. In many universities, researchers may not be involved at all, therefore the graduates are not trained for the challenges or opportunities envisioned in the country CAADP plan. Without national commitment and investment to fully embrace CAADP objectives, research may be undertaken in areas that are simply not vital for the future of food production and food security.

Given the renewed global interest in agricultural development and food security, important opportunities are on the horizon. The new U.S. Feed the Future initiative has carved out a role for science and research. The Obama administration has emphasized that, given U.S. budget constraints, research must be focused and practical, giving priority to developing technologies that will have the greatest impact on each country's agricultural challenges. The initiative's developing research strategy is the result of a broad consultation around priorities: advancing the productivity frontier; transforming production systems; enhancing nutrition and food safety; and addressing crosscutting challenges. This agenda will need to be enhanced by more creative and less dollar-intensive efforts within and outside the government.

In many parts of Africa, there is a general lack of advanced facilities, capacity in educational and research systems, and rigorously trained scientists. While some well-resourced universities and research centers do exist, they are by no means the norm. Centers of excellence in Africa, such as Makerere University in Uganda and the University of Nairobi in Kenya, have excellent agricultural research programs, but they are the exception rather than the rule. Furthermore, the current stable of scientists is aging, and declines in research investment, erosion of university research capacities, and a steep drop in international educational exchanges in agriculture science have meant that a younger generation of experts may not be sufficiently prepared to fill their shoes. Attracting and developing new researchers is complicated by a lack of incentives to attract the necessary human talent, such as noncompetitive salaries, and a pervasive intellectual tension between scientific excellence and practical, demand-driven research.

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19. Kwadwo Asenso-Okyere and Joachim von Braun, *A Bigger Role for Universities to Enhance Agricultural Innovation and Growth in Developing Countries*, Natural Resources, Agricultural Development, and Food Security, International Research Network, 2009, [http://economia.unipv.it/naf/Working\\_paper/WorkingPaper/OkyerevonBraun.pdf](http://economia.unipv.it/naf/Working_paper/WorkingPaper/OkyerevonBraun.pdf).

20. Nienke Beintema and Gert-Jan Stads, *Investing in Sub-Saharan African Agricultural Research: Recent Trends*, International Food Policy Research Institute, 2020 Africa Conference Brief 8, 2004, <http://www.asti.cgiar.org/pdf/ib24.pdf>.

## University System

Universities are responsible for training the scientists who will become the core researchers for national agricultural problems. The schools of agriculture usually train the researchers; but often the training is abstract and not well-connected to the agricultural challenges and opportunities facing the country. The system of extension, where professors and researchers have direct contact with farmers and users in the field, is not common in Africa. Agriculturalists who visit U.S. universities and extension systems often focus with great interest on the American habit of integrating research and technology into existing farming systems, and the important improvements and innovations that come as a result.

There are two additional challenges for universities, which are covered in more detail in the next section. First, greater integration with national strategies and priorities on agriculture is needed, so that students are trained to address the right problems, including those that have been prioritized through government planning, as well as those that will prepare students for work in the private sector. Second, knitting together priorities and plans among the departments of agriculture, science, and education is needed in order to produce graduates with practical scientific skills.

## National Agriculture Research Systems (NARS)

Within sub-Saharan Africa, NARS are the most prominent and well-resourced research organizations at the country level. NARS support overall research systems, focusing on improving research-delivery services.<sup>21</sup> Despite their favored status, many programs lack the capacity to meet their countries' vast agricultural research demands. At the national level, coordination among funding bodies and those setting agricultural R&D policy is often lacking. In many countries, the ministry of agriculture is responsible for the overall agricultural policy of the nation, relying on the universities for a steady supply of researchers. However, the ministry of education generally determines university priorities, without close consultation with the ministry of agriculture, resulting in uncoordinated and unfocused research planning and execution. The lack of communication between the institutions training scientists and the institutions hiring them often results in abstract and disconnected research results. The type of practical research undertaken in U.S. universities, especially in land-grant universities, where scientists have direct contact with farmers, is still largely unknown in African universities.

## Consultative Group on International Agricultural Research (CGIAR)

Layered on top of the national research program is a network of research centers that cuts across national, regional, and international boundaries. CGIAR, established in 1971, is the preeminent international body conducting research for agriculture in developing countries. It is a global alliance of international agricultural and natural resource research centers that carry out work on food security, nutrition, and climate change, and create technologies for smallholder farmers in the developing world. Four of the CGIAR's 15 research centers are located in Africa: the International Livestock Research Institute (ILRI), the Africa Rice Center, the International Institute of Tropical Agriculture (IITA), and the World Agroforestry Centre. The CGIAR's budget for 2009 was

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21. National Agricultural Research System, "About Us," accessed September 26, 2011, <http://www.naro.go.ug/About%20NARO/aboutnars.html>.

\$606 million.<sup>22</sup> All of the CGIAR research centers invest in programs for sub-Saharan Africa, and total expenditures in the region accounted for 51 percent of the total worldwide. The CGIAR is currently undergoing a major reform, to focus and target research beneficial to key staple crops for developing countries, and to ensure stronger partnership with local and national research centers and scientists. The effort is largely based around a shift of research priorities from the supply to demand side, so that the research centers are defining their needs in the context of what will be most useful in their country setting.

## Private Foundations

Foundations have been active in the research arena. The Alliance for a Green Revolution in Africa (AGRA) was founded to address research and productivity issues. Privately funded by the Bill & Melinda Gates and Rockefeller Foundations, AGRA is located in Nairobi. Kofi Annan, former secretary-general of the United Nations, chairs AGRA's board, and works with a team of distinguished African scientists, economists, and business leaders. With a current budget of close to \$400 million, AGRA is influential in shaping African agriculture policy. To date they have provided 116 grants to 83 countries, with an emphasis on building individual and institutional capacities. AGRA aims to double the income of 20 million smallholder families, and reduce food insecurity by 50 percent in at least 20 countries. It focuses on helping smallholder farmers gain access to enhanced seeds, soils, and market access to trigger changes throughout the agricultural system.<sup>23</sup>

The Partnership for Higher Education in Africa (PHEA) is another notable foundation promoting African education. PHEA was a consortium of seven foundations<sup>24</sup> that contributed \$440 million during the 10-year project (2000–2010), which coordinated their support for higher education in Africa. PHEA prioritized the importance of higher education in fostering social and economic development in Africa. Although this initiative did not focus solely on agriculture education, it made noteworthy contributions in expanding policy research and advocacy for African higher education; building physical, electronic, and management capacity; increasing the relevance of research conducted at the university level; and increasing the overall investment in African education across stakeholders.<sup>25</sup>

These various factors and actors have meant that a comprehensive approach integrating science education and research in support of local agricultural demands has too often been missing. Addressing the challenges that Africa faces will require a comprehensive approach that integrates science education and research in support of local agricultural demands. Research will need to focus on topics vital and specific to countries' land and farmers—for example, improving crops for drought resistance; increasing productivity for staple crops, such as cassava; and addressing challenges around soil quality, fertilizer use, water management, and pest control. Furthermore,

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22. CGIAR, "Who We Are: Donors and Funding," accessed September 22, 2011, <http://www.cgiar.org/who/members/funding.html>.

23. Growing Africa's Agriculture (AGRA), *About the Alliance for a Green Revolution in Africa*, accessed September 26, 2011, <http://www.agra-alliance.org/section/about>.

24. The Carnegie Corporation of New York, the Ford Foundation, the John D. and Catherine T. MacArthur Foundation, the Rockefeller Foundation, the William and Flora Hewlett Foundation, the Andrew W. Mellon Foundation, and the Kresge Foundation.

25. Suzanne Grant Lewis, Jonathan Friedman, and John Schoneboom, *Accomplishments of the Partnership for Higher Education in Africa, 2000–2010*, Partnership for Higher Education in Africa, 2010, <http://www.foundation-partnership.org/pubs/pdf/accomplishments.pdf>.

researchers will need to link directly with farmers to spur the application of their research. Gebisa Ejeta, a Purdue-trained Ethiopian plant scientist and World Food Prize laureate, has stressed the importance of “purpose-driven research”—that is, linking research with actual problems that farmers are currently dealing with in the field. Without intense focus on the problems in agriculture, research is likely to be academic and abstract, and dollars and time will be wasted.

## Part 2: Challenges to Strengthening African Universities

Africa’s research relies on universities to supply scientists and researchers. However, in the post-colonial period, African universities were designed primarily to serve as teaching institutions, while the ministries of agriculture undertook research and extension.<sup>26</sup> Structural adjustments in the 1980s also had deeply corrosive effects on even the most exemplary universities. Trends in development toward “basic education” have led to increasingly more people eager to continue their education and achieve greater incomes and quality of life. Providing these opportunities and building countries’ capacity to undertake modern agricultural research will require long-term investments in education at the graduate and postgraduate levels to rebuilding and restructuring these institutions to meet the challenges ahead. Africa’s overall development will be strengthened and enhanced through a strong focus and investment in higher education.

As with most higher-education institutions, African universities face challenges of funding and talent recruitment and retention. Due to funding constraints, professors are often required to spend increasing amounts of time teaching rather than conducting new research. The lack of opportunities to engage in innovative research, combined with relatively low salaries, makes it difficult for universities to recruit and retain professors. Additionally, funding for advanced laboratories and research infrastructure is limited. Programs and academic agendas must become more grounded in national priorities, and there is a serious need for universities to be engaged in the national discussion around agricultural priorities, so that graduates are trained in areas consistent with the needs of the overall research system. Connecting universities with the ministries of agriculture will move forward agendas more closely tied to farmers’ needs, and would provide data and training to farmers, which in turn would provide feedback and input so necessary to innovating in research efforts.

The current system provides some important opportunities. First, it is training students for work in the agricultural sector, as researchers, scientists, and extension specialists, so it is a good entry point for improving teaching methods, training, and research. Expanding efforts to train students to focus on science that affects all parts of the value chain, including post-harvest loss, food-safety protocols, and processing methods, is increasingly important as increasing productivity will rely on these processes to reach markets, especially for export. Second, because governments often have managing control of universities, there is an opportunity, too often foregone, to design programs that reflect national agricultural priorities and train graduates to undertake the work most needed in a country.

Challenges related to meshing national and university priorities include training students to perform at a very high level, and making research more practical to address issues along the agri-

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26. Carl K. Eicher, “Building African Scientific Capacity in Food and Agriculture,” *Review of Business and Economics* 3 (2009): 249.

cultural supply chain, from basic productivity to food processing, post-harvest loss, and supply-chain management. Strengthening universities' approach to agriculture, and integrating it much more deeply with national priorities and research centers, could yield significant results.

In light of these challenges, priority should be given to the “sandwich degree” model—programs that include training in both the home country and the United States, research focused on a home-country problem, and joint advisers from the home country and the United States. This leads to research procedures applicable to home countries, a deeper impact on institutional and individual capacities, lower costs, and important learning experiences for U.S. scientists and researchers.

Pilot projects involving this “sandwich degree” approach have been undertaken in Africa, for example, a two-year program in East Africa. Though a new effort, it produced interesting lessons. U.S. and African universities designed two types of “sandwich” programs. The first involves degrees conferred by African universities, where students spend time studying in the United States to further their understanding of advanced research methodologies; upon completion of all course studies, degrees are earned from the African university.<sup>27</sup> The second program is for students to earn degrees from U.S. universities—they participate in coursework in a U.S. institution, but conduct focused research at home. Both programs have the benefit of exposing the researcher to a broader range of scientific methods and problems, and a strong set of research advisers. In each case, mentors from both the U.S. and the African university provide guidance so that the students gain from their many years of experience. Some of the benefits of the approach are the capacity to address local problems, the eventual integration of these graduates into the university faculty, and the resulting institutional capacity.

The use of information and communication technology (ICT) is promising for university cooperation and communication. There is great potential, but the current state of both connectivity and education indicates that in-person exchanges will be most important for some time. Communication among researchers and faculty can be effective, through e-mail and teleconferences, using Skype, for example. However, important limitations include the technology infrastructure being uneven and unreliable in many places. The potential for distance learning seems great, but the level of coursework in some universities is not adequate for graduate-level exchanges with U.S. institutions. So while this is an area with tremendous opportunity, increased communication through in-person exchanges remains a priority.

## Programs and Partners to Address Research Challenges

Several programs are under way in the United States to foster scientific cooperation. USAID has engineered two important programs committed to building research capacity at the university level: The Collaborative Research Support Programs (CRSP) and the African-U.S. Higher Education Initiative partnerships led by the Association of Public and Land-grant Universities (APLU). Both of these programs invest in establishing long-term partnerships between American universities and institutions in developing countries. Frequently, the establishment of functional and productive exchanges is the most difficult part of building partnerships, so these programs bridge a crucial gap for meaningful and sustainable capacity building.

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27. Andrew Gilboy, Cornelia Flora, Ron Raphael, and Bhavani Pathak, *Agriculture Long-Term Training: Assessment and Design Recommendations*, USAID, August 2010, [http://pdf.usaid.gov/pdf\\_docs/PNADT511.pdf](http://pdf.usaid.gov/pdf_docs/PNADT511.pdf).

The CRSPs represent a series of institutional partnerships between American land-grant universities and universities in developing countries. The CRSPs were founded in 1975 and consist of long-standing joint research efforts, involving U.S. universities with their counterparts in developing country universities, NARS institutions, the CGIAR system, the private sector, and NGOs. The CRSPs have come to be well regarded and are considered effective. Importantly, the CRSPs focus on a specific research problem common to the institutions.<sup>28</sup> Funding for these programs has increased by roughly one-third over the past 10 years, to an estimated \$30.5 million for FY2011 to fund 10 CRSP programs currently under way.<sup>29</sup>

Some CRSPs have been active for decades, while others are new. A long-standing example is the Peanut CRSP, which has been active since 1982 at the University of Georgia, and is doing research on improving peanut-farming practices in West Africa.<sup>30</sup> Another, more recent example is the Sorghum, Millet and Other Grains (SMOG) CRSP, which has developed over 30 stress-tolerant and high-yielding sorghum varieties, as well as soil-management best practices that have increased sorghum yield by 20 to 50 percent. According to USAID, the economic benefit of some of the technologies is as high as \$9.90 for every \$1.00 spent on research and development. The introduction of these technologies, a new and innovative marketing strategy, and farmer training significantly increased sorghum yields in Senegal, Mali, Niger, and Burkina Faso. The combined effect of the yield and price gains on farmers' income has been dramatic—as high as 278 percent in Senegal.<sup>31</sup>

These collaborations receive high marks for solving real problems through research. They could be an important way to target scarce U.S. government research dollars going forward. As USAID's Feed the Future initiative gets under way, Administrator Rajiv Shah has underlined the importance of the CRSP programs, noting that the CRSPs have set a good example for some of the long-term collaborations that the Feed the Future hopes to build off of going forward.<sup>32</sup>

The Higher Education for Development (HED) program was established in 1992 as a mechanism to fund higher-education partnerships involving U.S. and Global South institutions. Attention to its mandate and continued funding reflects a commitment at USAID to capacity building through investments in higher education. HED supports partnerships between U.S. colleges or universities and higher-education institutions in developing countries. HED works with six U.S. presidential higher-education associations to facilitate its 14 partnerships. It received \$7.4 million from USAID and \$6 million from partner institutions in FY2010.<sup>33</sup> While HED invests in all aspects of higher education, some of its most productive partnerships focus on agricultural research in Africa. For example, Michigan State University and Makerere University in Uganda have a strong partnership that began in 1998. The project focuses on zoonotic disease, and its results have

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28. CRSP, "About Us: Historical Perspective and U.S. Government Policies," May 19, 2011, <http://crsps.org/aboutus.htm>.

29. Harry Rea, Aquaculture and Fisheries Adviser, USAID, Bureau of Food Security, interview, July 22, 2011.

30. Peanut Collaborative Research Support Program, accessed September 26, 2011, <http://peanutcrsp.org/>.

31. USAID, *USAID Support for the Collaborative Research Support Program*, FactSheet. 2009, [http://www.usaid.gov/our\\_work/agriculture/pdfs/2009/CRSP\\_factsheet.pdf](http://www.usaid.gov/our_work/agriculture/pdfs/2009/CRSP_factsheet.pdf).

32. Lindsey Sutphin, *Feed the Future: A New Way of Doing Development*, Sustainable Agriculture and Natural Resource Management (SANREM), OIRED/Virginia Tech, accessed September 26, 2011, <http://www.oired.vt.edu/sanremcrsp/public/news/2010/Feed-the-Future.php>.

33. Letter from Terry Hartle, chair of HED board, in *Higher Education for Development: 2010 Annual Report*, 1, <http://www.hedprogram.org/ReportsPublications/2010HEDAnnualReport/tabid/284/Default.aspx>.

had a solid impact. An important contributor to successful programs has been the strength of the partnership between universities and researchers: the stronger the personal ties are, the greater the benefits from the collaboration through lasting personal contacts, communications, and shared knowledge.

More recently, HED has assumed management responsibility for 11 partnerships between U.S. and African universities, seven of which are focused on solving problems related to agriculture, such as food security, water, soil quality, trans-boundary animal disease, and ecosystems services. These partnerships are intended to be long term and to involve collaborative research in addition to outreach to stakeholders and improvement in curricula.

The health field holds well-resourced models. One of particular interest is the Fogarty International Clinical Research Scholars and Fellows program (Fogarty Fellowship Program). These fellowships are small, individually focused partnerships in the health sector. They serve as an example of scientific collaboration that may be replicated for agriculture. The Fogarty Fellowship Program, funded by the National Institutes of Health (NIH), has been very successful in connecting U.S. and international scientists around specific problems, creating long-term partnerships and collaboration, and building a powerful network of alumni. Almost more important than funding levels in these partnerships has been their ability to sustain and nurture themselves over time. The Fogarty International Center is currently appropriated \$52.8 million dollars from the federal budget annually for extramural activities, which are composed of competing and non-competing awards.<sup>34</sup> This is an enormous sum compared to similar fellowships focused on agriculture. With increased funding, these fellowships could be leveraged for sustainability and effectiveness, such as has been seen with the Fogarty Fellowships.

Both the CRSP and NIH models use some of the same approaches to encourage researchers to return to their home countries. The key elements include: focus on research that is a priority in the home country; “sandwich training,” during which the beginning and end of the training take place in the host-country institution and the middle occurs in a home-country institution; mentoring programs in both the United States and home country; access to often expensive electronic journals and media; reentry funding that provides researchers with bridge money to allow them to continue their research and establish themselves; and agreements to encourage researchers to return home.<sup>35</sup>

The USDA also has international fellowships that promote partnerships to help protect and better leverage U.S. agricultural interests abroad. The small size of these programs allows them to be flexible; they address a wide range of specific problems by linking African and U.S. scientists working on common issues.

The Foreign Agriculture Service (FAS) manages programs that advance agricultural science cooperation in the Office of Capacity Building and Development (see boxes 1 and 2). These FAS programs are fairly small, hosting on average fewer than 50 fellows each year, but they often use a training-of-trainers model, so that whenever possible the acquired knowledge can be disseminated when fellows returns to their home countries.

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34. NIH Fogarty International Center, “Funding Strategy Fiscal Year 2011,” <http://www.fic.nih.gov/about/fundingstrategy/pages/funding-strategyfy2011.aspx>.

35. Linda Kupfer, Karen Hofman, Raya Jarawan, Jeanne McDermott, and Ken Bridbord, “Strategies to Discourage Brain Drain,” *Bulletin of the World Health Organization*, 82 (8), August 2004, Round Table, <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2622924/pdf/15375452.pdf>.

One of the more prominent examples of the USDA scientific fellowship program is The Norman E. Borlaug International Agricultural Science and Technology Fellowship Program (Borlaug Fellowship Program) funded with a \$1 million annual appropriation. The program, which began in 2004 but did not receive appropriations from Congress until 2008, helps developing countries strengthen sustainable agricultural practices by providing scientific training and collaborative research opportunities to researchers, policymakers, and university faculty. It provides fellowships to roughly 30 scientists per year, many of whom are African. Fellows submit proposals identifying a specific issue and university they would like to partner with, and accepted applicants spend 6 to 12 weeks on collaborative research. Each scientist is matched with a mentor at the American university who visits the fellow in his or her home country for a follow-up meeting the following year.<sup>36</sup>

The National Institute of Food and Agriculture (NIFA) is the USDA's institute for "extramural" research funds—that is, funding research done outside USDA, primarily at land-grant universities. NIFA's mandate focuses on research to achieve domestic agricultural goals. NIFA serves as a valuable intermediary between U.S. universities and institutions abroad on agricultural issues. Its purview has recently been expanded to permit international partnerships abroad.

More than 500 U.S. universities apply for USDA/NIFA grants each year, and NIFA has been able to augment the scope of its RFPs to allow research that will solve dual problems—for example, a particular pest or problem that affects crops in both the United States and in a partner African country. USDA's important role could be further developed by encouraging U.S. universities receiving science and education grants to build an international component into their work. Once these relationships are established, they often lead to long-term partnerships that can be mutually beneficial.

Note that the law requires these programs to focus on promoting and increasing U.S. agriculture exports. Programs undertaken by FAS or NIFA must comply with this mandate, but a great deal of knowledge and skill within USDA's science

#### Box 1

**The Faculty Exchange Program** targets university professors, bringing them to U.S. universities to build or revise their curricula. The subjects cover a wide range—from biochemistry to food safety—and result in stronger courses and institutions as a result of better coursework, updated scientific methods and information, and new course materials. Much as the Borlaug Fellowship Program, the FAS identifies target countries by working with American embassies and USAID country offices, prioritizing those applications that stand to gain the most from such an exchange.

#### Box 2

**The Cochran Fellowships Program** provides short-term (two-week) programs for individuals to visit the United States and build capacity by focusing on a specific agribusiness or regulatory problem. For example, a country may need additional support in achieving phytosanitary standards or easing trade regulations. A Cochran fellow can arrange meetings with pertinent U.S. experts to learn about the technology, methods, and processes required to achieve the desired goal. The Cochran Fellowship Program operates in 70 countries focusing on middle-income countries and emerging democracies. Since its start in 1984, the program has provided training for more than 14,300 participants from 123 countries.

36. Ali Abdi, Foreign Agriculture Service (FAS) officer at USDA, interview, July 29, 2011.

and research programs can be useful in building long-term international capacity. This investment can benefit U.S. producers through better research, technology, stronger safety standards, and shared scientific outcomes that can be applied to U.S. farms.

## International Involvement

The United States is not alone in its focus on these issues. European countries have been active in supporting African research and development, as have private organizations such as the Bill & Melinda Gates Foundation and the Rockefeller Foundation. The United Kingdom and Germany provided over \$20 million in support of the CGIAR in 2010; and many countries have a legacy of engagement in education and exchanges based on colonial ties. The Japan International Cooperation Association (JICA) has been a leader on research, especially related to rice, and has programs in place throughout Africa.

The Global Forum on Agricultural Research (GFAR) is an international body based at the Food and Agriculture Organization of the United Nations (FAO) that works to mobilize all parties involved in agricultural research to meet development goals and decrease poverty by improving linkages and coordination between research investment and development outcomes at a global level. Its members are a wide array of international agricultural stakeholders, such as farmers and farmer organizations, civil society, national agricultural research and extension agencies, the private sector, international research centers, fundamental research institutions, and donor organizations. In 2010, GFAR also organized the first Global Conference on Agricultural Research for Development (GCARD), which promotes agricultural research to address the needs of poor farmers by investing at all levels of the agricultural system.

Brazil is another model, having achieved remarkable increases in productivity as a result of serious investments in agricultural research. The Brazilian Enterprise for Agricultural Research (Empresa Brasileira de Pesquisa Agropecuária, EMBRAPA) is an excellent example of one such investment. Started in 1973, EMBRAPA is an agricultural research center that, through a strong partnership with USAID and JICA, was able to transform huge swaths of unusable land into fertile farming land. The primary architects of EMBRAPA hold advanced degrees from U.S. land-grant universities, and include Almiro Blumenshein, who received his PhD from North Carolina State, and Eliseo Alves, whose PhD is from Purdue. USAID investments in human and institutional capacity building in agriculture in Brazil during the 1960s and 1970s paid high dividends and seeded the work of the institution. Since 1973, it has generated and recommended over 9,000 technologies, which have helped to decrease production costs, increase yields, and increase uptake of agriculture throughout Brazil. Today, it has 54 facilities and over 8,000 employees.<sup>37</sup> Brazil currently produces the most beans, sugar cane, green coffee, and oranges globally, and the agribusiness sector makes up 25 percent of the world economy.<sup>38</sup> China has achieved similar growth through macroeconomic reform and investments in infrastructure. Output in the agricultural sector increased 61 percent between 1978 and 1984.<sup>39</sup>

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37. EMBRAPA, “About Us,” accessed September 26, 2011, <http://www.embrapa.br/english/embrapa/about-us>.

38. USDA, Foreign Agriculture Service, *Agricultural Economy Policy Report—Brazil*, Foreign Agriculture Service, February 2009, <http://www.fas.usda.gov/country/Brazil/Brazil%20Agricultural%20Economy%20and%20Policy.pdf>.

39. John McMillan, John Whalley, and Lijin Zhu, “The Impact of China’s Economic Growth Reforms on Agricultural Productivity Growth,” *Journal of Political Economy* 97, no. 4 (1989): 1–3, <http://www.jstor.org/stable/1832191>.

Brazil and China can be important partners, and should be studied as models, both as partners and as leaders in this field. Brazil, for example, has done work with Lusophone African countries, in partnership with JICA. The potential for the type of research and technology developed in countries like Brazil and China is strong, and partnerships and relationships should be encouraged and fostered.

The challenge for U.S. efforts is finding the right investment priorities. It will be important for African countries to engage in strong and collaborative planning so that U.S. resources can target those areas that are priorities for each country and will have the greatest impact.

In recent years, partnerships with the private sector have increased. These collaborations will play a greater role in enhancing the level of resources, in targeting highly practical research, and in providing technical expertise. The following section examines examples of partnerships currently at work on specific problems. These are promising and are likely to be more prominent in the future. It will be important to understand the possibilities and limitations of partnerships, and to focus private efforts on public outcomes.

### Part 3: Private-Sector Engagement in Research

In a time of constrained government budgets and increasingly complex food security challenges, the need for partnerships with the private sector, universities, governments, research institutions, NGOs, and farmers groups is growing. Partnerships are not easy and take time and extensive communication, but they are important for dealing with problems that require large investments, advanced technological solutions, and a lengthy timeframe. The private sector has played a leading role in U.S. agricultural research for many years, especially in providing human and financial capacity, integrating results from the lab and field into new research, and developing public awareness of the importance of scientific gains. There is tremendous room for growth in Africa, so it is even more critical now that the private sector be engaged in furthering the research agenda in Africa. The private sector has the interest and capacity to address challenges such as productivity and drought tolerance; but there are still some significant policy challenges to overcome in the areas of intellectual property, liability and regulatory structures, and communication in realizing more of these collaborative efforts.

A recent Global Harvest Initiative review concludes that the overall investment gap in the agricultural sector in developing countries approaches \$90 billion annually. This estimate clearly indicates the enormity of the task of doubling agricultural output within 40 years.<sup>40</sup> The gap reflects a major investment need and emphasizes the importance of finding effective ways to channel capital, technology, and capacity into the agricultural sector of developing countries and the need for multiple partners to be engaged in the process.

A large portion of private-sector research and development in agriculture is done by the United States and Japan.<sup>41</sup> In the 1960s in the United States, private-sector investments in agricultural research were 5 percent less than public-sector investments. By 1995, that figure had increased

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40. Global Harvest Initiative, *Enhancing Private Sector Involvement in Agricultural and Rural Infrastructure Development*, June 27, 2011, <http://www.globalharvestinitiative.org/index.php/policy-center/enhancing-private-sector-involvement-in-agricultural-and-rural-infrastructure-development/>.

41. Sara Curran, Cameron Clark, and C. Leigh Anderson, *R&D Finance for Agriculture in Sub-Saharan Africa*, Evans School of Public Affairs, University of Washington, May 13, 2009, <http://evans.washington>

drastically, and private-sector investments are now more than three times those of the public sector.<sup>42</sup> Currently, private-sector investments in sub-Saharan Africa are quite small, accounting for 2 percent of research and development. These investments have been concentrated in a few countries with a developed research infrastructure, such as Nigeria and South Africa. Investment, as of yet, in many of the more developing countries in sub-Saharan Africa has been minimal.<sup>43</sup> This lack of investment results in a lack of scientific capacity; a gap in the type of crop and research knowledge that is most applicable for African soils, crops, and livestock; and limits to the growth of commercial distributors and markets for new products and technologies.

While the importance of private-sector financial investment should not be underestimated, partnerships are valuable only partly due to the financial resources they bring. A significant portion of the funds that U.S. agriculture companies allocate for research and development is directed at products, such as corn and soybeans, that will generate greatest profits in key markets of the United States and other developed countries. However, these companies also create vast amounts of information that may have important applications for non-commercial crops. In highly technical areas, such as plant and animal science and private-sector intellectual property (including germplasm and proprietary research), technical expertise and laboratory facilities are essential to successful research.

Some crops in the developing world, such as cassava and eggplant, are not widely cultivated by large-scale farmers, so there is little market incentive to invest in the long and expensive process of developing new varieties to bring to market. However, when existing technology and research can be applied in developing countries for local research needs, it can jumpstart research and result in new findings and technologies. The ability to more easily introduce technology and expand markets in developing countries is an appealing prospect for private companies.

The benefit that partnerships can have is similar to the benefits of the long-term collaboration between U.S. and African universities, only in some ways they may be even more durable, especially for partnerships in Africa. Research partnerships will be most valuable to African countries when the project is practical in its approach and addresses local needs, such as creating a new strain of crop or combating a damaging disease or pest. (See box 3 for some examples of current partnerships.) Additional long-term benefits can result when the effort is developed in a way that builds stronger research capacity in the host country. One such example is the work by the African Agriculture Technology Foundation (AATF). Box 4 highlights some of the collaborative research that AATF has under way on bananas, maize, and *Striga* control. Each collaboration targets a specific outcome that will improve food security for consumers and improve economic returns for farmers. In the future, research teams engaged in these partnerships can apply lessons learned in new projects to strengthen agricultural research outcomes in Africa. From researchers to administrative support to local farmers, a tremendous outcome of these partnerships is that the environment of research and innovation spreads and creates a stronger sense of the importance of science and scientific capacity.

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.edu/files/Evans%20UW\_Request%2035\_Financing%20in%20Ag%20Research%20and%20Development\_05-13-2009\_0.pdf.

42. Clive James, *Progressing Public-Private Sector Partnerships in International Agricultural Research and Development*, International Service for the Acquisition of Agri-biotech Applications (ISAAA), 1997, <http://www.isaaa.org/resources/publications/briefs/04/download/isaaa-brief-04-1997.pdf>.

43. Ibid.

### Box 3

Dr. Emily Twinamasiko, director of research coordination at the National Agricultural Research Council Secretariat in Uganda, described three important partnerships currently under way in Uganda.

Cassava, or manioc, is a key staple crop in many countries—in fact, it is the world's fourth-largest staple.<sup>1</sup> Uganda has a partnership with the Donald Danforth Plant Science Center, the National Agricultural Research Organization (NARO), the Kenya Agricultural Research Institute (KARI), Monsanto, and USAID that is focused on addressing cassava mosaic disease and cassava brown streak disease. Though it had long moderately affected crops, in the late 1980s cassava mosaic disease became a very serious threat, especially in Uganda. A new strain wiped out crops and led to famines in the 1990s. This research is focused on controlling these diseases by developing a plant with virus resistance.

Banana biotechnology is aimed at increasing productivity and improving nutrition by developing banana varieties resistant to nematodes, weevils and sigatoka, and that are fortified with Vitamin A, which is important for vision. The effort is a partnership with universities in the United States, Australia, and Europe; U.S. companies; and Israel and Uganda.

Water-efficient maize for Africa is a collaborative effort to develop tropical hybrids with drought-tolerant genes. The goal is to develop products that are accessible to smallholder farmers. The technology would be made available without restrictions based on intellectual property rights.

This partnership is a major effort between AATF; Monsanto; the International Maize and Wheat Improvement Center (or Centro Internacional de Mejoramiento de Maíz y Trigo, CIMMYT), and African national research institutions.

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1. Claude Fauquet and Denis Fargette, "African Cassava Mosaic Virus: Etiology, Epidemiology, and Control," *Plant Disease*, June 1990, Laboratoire de Phytovirologie, ORSTOM (Office de la Recherche Scientifique and Technique d'Outre-Mer), Abidjan, Ivory Coast, [http://www.apsnet.org/publications/PlantDisease/BackIssues/Documents/1990Articles/PlantDisease74n06\\_404.pdf](http://www.apsnet.org/publications/PlantDisease/BackIssues/Documents/1990Articles/PlantDisease74n06_404.pdf).

Some significant challenges are inherent to partnerships around agricultural research. Intellectual property is perhaps the first issue to be addressed. In many cases, companies donate the intellectual property, as with the project to develop Water Efficient Maize for Africa (WEMA). In this project, the private-sector partner, Monsanto, donated the germplasm, highly valuable intellectual property, and maintained no ties to the rights of the product. It is important for partners—and observers—to view this as a high-dollar, in-kind contribution. When dealing with abstract concepts such as germplasm, it may be tempting to consider the technology an easy item for a company to donate, but such technology results from years of research and significant investments, so it is important to acknowledge the level of intellectual property contained.

A second major policy challenge is the liability and regulatory structures. In a project that develops new technology, risks relate to both the company and the end-user. For the end-user, the risk is that investments in new seeds or varieties will not succeed, and valuable funds and time will be lost. For the companies that contribute technology, funds, and skills, the concern is that they will be held responsible if the new technologies are not effective, or that providing technology in an area where regulations are new exposes the company to unacceptable risk for litigation.

Indeed, an important effect of building partnerships in-country is using U.S. corporate and government expertise on developing frameworks for regulation and approval. The U.S. government has done a great deal to support the development of strong regulatory frameworks in countries moving forward with more advanced agricultural research. The knowledge of U.S. officials, combined with the practical experience of scientists from the private sector, provides important support to African countries grappling with the regulatory issues surrounding scientific research and, in some cases, biotechnology.

For these reasons, communication, farmer and public engagement, and strong regulations are essential. For partnerships around agriculture and research, it is essential to foster buy-in from all stakeholders and to encourage a discussion around the role of research and science in the country's future. For new technologies to take hold among farmers and be accepted by consumers, a strong set of dialogues must occur along the way. First, there must be a dialogue with the relevant government agencies regarding any type of regulation or approval that new research or technology might need to be used. The systems should be designed with the end-user—the farmer—in mind, and that protect indigenous technologies and innovations. This is especially important for biotech-

#### Box 4

**The importance of neutral facilitators:** An important actor is the African Agricultural Technology Foundation (AATF), a nonprofit organization established with a grant from the Rockefeller Foundation, which facilitates and promotes public-private partnerships developing agricultural technologies for smallholder farmers in sub-Saharan Africa. AATF focuses on helping African farmers get access to proprietary technology.<sup>1</sup> One of the first projects that AATF facilitated was to reduce the threat of Striga to maize production in sub-Saharan Africa. The StrigAway technology combines high-yielding maize varieties that are resistant to Imazapyr herbicide and the coating of maize seeds with the Imazapyr herbicide that is effective in killing Striga. In 2008, trials conducted by AATF and partners in the fields of farmers in western Kenya conclusively demonstrated the effectiveness of StrigAway with maize yields increases of up to four times from Striga-infested plots.<sup>2</sup> So far, AATF has reached more than 2,700 farmers on a one-to-one basis.

1. AATF strategy document, <http://www.aatf-africa.org/userfiles/strategicdirection1.pdf>, p. 8.

2. AATF annual report 2009, <http://www.aatf-africa.org/userfiles/annual2009.pdf>, p. 11.

nology. USAID, the State Department, and many partners have done extensive work to build biosafety capacity for over a decade. Countries including Kenya and Uganda have developed much stronger capacities to create biosafety laws and regulations that enable smallholder farmers to have access to improved technologies while also reflecting national preferences. Second, there must be a public dialogue about the role of science and research in agriculture, and the type of work being done through these partnerships. This is especially important if large, U.S.-based corporations are involved, as there can be a considerable suspicion around intent. And finally, it is vital to have an ongoing dialogue with the farmers who will be the end-users. Without these individuals' buy-in and understanding, new seed varieties and new research will not be used, commented on, and improved, such that increased yields or reduced use of pesticides may not be reached. This is the process that has made U.S. agricultural research so effective, and farmers must be engaged on an ongoing basis.

Successful partnerships of a significant size should be organized by a governing body that includes all the relevant parties—the host government; the private-sector

partner; the international government partners; and in most cases, a party perceived as neutral, such as an NGO, a university, or a foundation. The participation of a neutral party is important because host governments must feel that their interests are being protected when dealing with sensitive policies, such as biotechnology regulations or intellectual property rights. Neutral leadership assists in the critical step of transferring technology to farmers in a way that creates knowledge and acceptance, and ensures that technology's capabilities are maximized to meet the project's goals, such as productivity, reducing incidence of disease, or improving nutrition.

#### **Box 5**

**Are GMOs the answer for Africa's food security?** It is tempting to consider the potential for improved seeds, including genetically modified seeds, for increasing African farm production. The reality, however, is that it is not that easy. For seeds and new crop varieties to be successful, they must first be bred for local conditions. Then they must be field-tested and further modified to accommodate the soil and weather where they are to be grown—a process that can take many years. Finally, there must be a demand from farmers for the new seed—seed that is more costly than saved seed, and that may not produce a product appealing to consumers.

Currently, about 25 percent of African land is planted with improved seeds, that is, a seed with any kind of modification, from traditional breeding to transgenic breeding and genetic modification (GM). Simply providing farmers with better seeds is not the answer—seeds and other inputs have to be proven to improve yields and reduce farm labor, and farmers need ongoing training to use them effectively, as well as sound legal and regulatory structures and improved market access.

Discussions with many African agricultural specialists indicate support from the scientific community for biotechnology. However, they caution that their countries must develop a more active dialogue with scientists, policymakers, and the public, so that the final decision about progressing on biotech and GM technology will be scientifically based, and the result of indigenous research and innovation. In fact, only three African countries allow genetically modified organisms (GMOs)—Egypt, Burkina Faso, and South Africa. And only South Africa allows GMO technology for food. Burkina Faso has approved only a strain of cotton resistant to the bacillus thuringiensis (Bt) virus.

Going forward, there are specific problems in Africa that GM technology may be able to address. The Water-Efficient Maize for Africa (WEMA) project is an example of a genetically modified crop being developed to survive in Africa's hot and arid climate. This is promising technology, and has been approved for field trials in Tanzania, Uganda, Mozambique, Kenya, and South Africa. For any kind of new technology to succeed, however, there must be strong regulations and a healthy dialogue between the scientific community, the policy community, and the public, where final regulations represent a strong consensus.

A key challenge in developing new agricultural research is getting it into the hands of farmers. Partnerships that can enhance farmer and researcher capacity will smooth the transition of new technologies into formal use. And developing products, including seeds, insecticides, and pesticides to benefit farmers, takes considerable expertise and practice. Companies in this field have extensive experience in working with farmers in the United States and other countries to run

field trials, identify best traits, and develop crops that will exhibit those traits. This kind of product development may ultimately determine the success of certain crops as they leave the lab and enter the field.

In recent years, the foundation community has also made major contributions to African agricultural research, and has become influential in shaping its priorities. The Bill & Melinda Gates Foundation in particular has been extremely active. Since its inception the foundation has committed \$244.2 million to agricultural research and development, focused largely on sub-Saharan Africa.<sup>44</sup> Currently, the National Science Foundation and the Gates Foundation have an innovative project under way called BREAD (Basic Research to Enable Agricultural Development).<sup>45</sup> The program promotes research that directly applies to rural smallholder farmers in Africa, specifically focused on ways to increase productivity.

In 2006, the Bill & Melinda Gates Foundation and the Rockefeller Foundation funded development of Alliance for a Green Revolution in Africa, or AGRA, an organization to develop advancements in the use of high-yield food crops. AGRA undertakes a variety of projects to promote agricultural growth among smallholder farmers. The Program for Africa's Seed Systems (PASS) was the first AGRA initiative and was formally launched in 2007. Its goal is to promote the development of seeds that deliver improved crop varieties to smallholder farmers, focusing on supporting crop genetic improvement and seed supply for Africa.<sup>46</sup> PASS has four sub-programs that form a seed value-chain, from educating plant breeders and seed specialists to putting improved seeds on the shelves for farmers and agro-dealers.<sup>47</sup>

## Conclusion and Recommendations

Four key objectives emerged in the course of the CSIS roundtable discussions. Advancing the objectives of achieving greater food productivity and security will require political commitment and renewed appreciation of the role of science and research both in U.S. assistance and in African political leadership, and will benefit from the following approaches.

**Focus on Problems.** Achieving results will require serious focus. Focus on the most real and serious problems in African agriculture and attack them in a coordinated way in local settings. Ultimately it will be up to African partner countries to set, through consultation, their respective development and research agendas. Encouraging partners to formulate and articulate national research priorities will help guide U.S.-African partnerships and lead to greater coordination and synergies across multiple actors and institutions.

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44. Bill & Melinda Gates Foundation, "Agriculture and Development: Strategy Overview," accessed September 26, 2011, <http://www.gatesfoundation.org/agriculturaldevelopment/Documents/agricultural-development-strategy-overview.pdf>.

45. Basic Research to Enable Agricultural Development (BREAD), National Science Foundation, Program Solicitation NSF 10-589, accessed September 26, 2011, <http://www.nsf.gov/pubs/2010/nsf10589/nsf10589.htm>.

46. Tiff Harris, "AGRA in Perspectives: AGRA Programs and Initiatives," in *AGRA in 2008: Building on the New Momentum of African Agriculture* (Nairobi, Kenya: Alliance for a Green Revolution in African Agriculture, 2009), 10, [http://www.agra-alliance.org/content/search?search\\_query=AGRA+in+2008%3A+Building+on+the+New+Momentum+of+African+Agriculture&x=18&y=5#Document](http://www.agra-alliance.org/content/search?search_query=AGRA+in+2008%3A+Building+on+the+New+Momentum+of+African+Agriculture&x=18&y=5#Document).

47. Ibid.

- The United States should increase the use of CRSPs for problem-solving around issues relevant to both African and U.S. researchers and farmers. Funding for CRSP should increase, but only for focused problems that have a practical application in the African country. Although CRSPs have not required major funding, their short-term effect in problem-solving and their longer-term effect in building institutional linkages and capacities have been significant.
- Create a USAID “Grand Challenge” that tackles a specific problem facing agriculture that fits with Feed the Future research priorities, such as improving nutrition through science or increasing incomes by reducing crop loss. The challenge should require collaboration with U.S. institutions and outreach to the public in the country where it is based. This and other similar initiatives will highlight the importance of research in meeting practical and pressing challenges and will give greater profile to innovative and focused thinking by U.S. and African researchers.
- U.S. efforts should also strongly emphasize scientific cooperation in the areas of food processing and the reduction of post-harvest loss. In some countries, one-third of production is sacrificed to post-harvest loss; this, along with productivity enhancements, has great potential for research efforts in Africa.<sup>48</sup>
- As focused research partnerships move forward on advanced agricultural technologies, the Department of State and USAID should continue their work, in partnership with African government ministries of environment and agriculture, in assisting countries to develop frameworks for biotechnology and intellectual property rights that will create consistency for these agreements. Field trips and visits of agriculture and environmental ministries can be helpful to demonstrate the positive impacts of biotechnology, as well as to share information with other countries who have adopted biotechnologies like Burkina Faso and Brazil.

**Prioritize Individual Capacities to Improve Institutions.** The individual researcher is still the bedrock for strong scientific advancement and institutional capacity. Although improving individual capacity is not the only way to strengthen institutions, it is vital to building capacity for the long term. Strengthening science and research capacity should be an important and consistent priority in U.S. assistance and in partner countries’ longer-term development strategies. Efforts should begin at the secondary-school level, through the university level, and to partnerships that continue to enhance existing capacities. More opportunities should be available for researchers to focus on problems relevant to their native climates and crops.

- Provide support for short-term research fellowships for African scientists in partnership with U.S. researchers. Borlaug Fellowships, with a current appropriation of \$1 million, could increase the number of researchers by 50 percent by increasing the appropriation by \$500,000—which should be possible even in the current budgetary environment. Partnerships or funding from external sources could increase the number of researchers selected.
- Increase the use of information and communications technology, or ICT, in research. Connect with U.S. universities and private entities for problem-solving and research sharing. Online coursework can be challenging in Africa, with disruptions in electricity and Internet access and uneven levels of student readiness; also, electronic access to scientific literature is limited

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48. CSIS, *Cultivating Global Food Security, A Strategy for U.S. Leadership on Productivity, Agricultural Research, and Trade*, a report of the CSIS Task Force on Global Food Security (Washington, D.C.: CSIS, April 2010), [http://csis.org/files/publication/100422\\_Food\\_%20Security\\_WEB.pdf](http://csis.org/files/publication/100422_Food_%20Security_WEB.pdf).

and expensive. But it can be a powerful tool in productively connecting research fellows with former partners or professors and in maintaining the ties developed through research partnerships.

- Wherever possible, include follow-up steps in research programs. Fellows should be required to have annual follow-ups with the research institutions where they studied, either in person or through ICT technology.
- While sponsorship of African students at U.S. land-grant universities may no longer be possible on a large scale, these universities should be encouraged to partner with African counterparts, collaborating on curriculum development; sharing best practices in applied research and linking with farmers and extension services; and strengthening university faculty with mentoring and consultations, as well as possible faculty exchanges. One way to do this is by requiring, or at least encouraging, international partners through grants and programs.
- Encourage leader-to-leader exchanges. Opportunities for communication and exchange between deans and provosts in agricultural colleges will lead to the development of enduring ties, stronger leadership, and strengthened institutions.

**Foster Collaboration within National Scientific Community.** There are significant benefits of scientists working together—on a problem, in a laboratory, and in a way that encourages lasting communication. In its assistance, the United States should encourage and incentivize priority setting, collaboration, and communication in partner countries at the national level and at the regional level.

- Use partnerships to promote greater scientific interaction. In addition to focused research in countries, private companies can contribute a great deal by hosting scientists for fellowships in their laboratories, or providing teaching and research opportunities for their scientists to work in African institutions.
- As the United States bolsters research capacity, it should work in concert with other international actors in Africa to support individual countries' national research agendas. In this regard, communication and engagement with emerging players—for example, India, China, and Brazil—which have valuable research capacities and experience to bring to the table, will be important. As the CGIAR engages in organizational reform to focus its work on the priorities of developing countries, the United States should look for ways to focus its resources on investments led by the priorities of the consultative group and participating developing countries.

**Promote Institutional Coordination and Communication.** It is vitally important for scientific research in Africa to be more coordinated—for goals and strategies to be set at the national level, and for all levels of research centers, universities, and partnerships to support these goals. It cannot be underestimated how crucial the role of good governance and leadership will be in promoting coordination, supporting innovation, and attracting essential private-sector investment.

- Ensure that African governments bring university research back into the loop; universities need to be engaged in setting goals and research priorities related to CAADP.
- Require a communications plan for any major research effort, to develop within the public a greater understanding of agricultural science and its benefits, and to create a demand and constituency for stronger and more focused scientific research.

- Use research collaborations to train researchers on how to communicate with the public about research goals and findings, and their practical application and to engage with policymakers to ensure that decisionmaking in agriculture is evidence-based and takes greatest advantages in the opportunity that innovation and new technologies present.



## APPENDIX

# WORKING GROUP MEETINGS OF THE CSIS U.S.-AFRICAN AGRICULTURAL SCIENCE ROUNDTABLE

### Meeting 1, August 23, 2010: What is the Current Nature of Agricultural Science and Research in Africa?

#### *Speakers:*

**Dr. Ousmane Badiane**, *Director, Africa, International Food Policy Research Institute (IFPRI)*

**Dr. Eugene Terry**, *Senior Technical Adviser, TransFarm Africa, board member, the World Vegetable Centre (AVDRC), the Syngenta Foundation for Sustainable Agriculture (SFSA), and the West Africa Centre for Crop Improvement (WACCI), and Founding Director of the African Agricultural Technology Foundation (AATF)*

#### *Discussion Questions:*

- How is research organized in Africa, and what is the state of the research establishment in key African countries?
- How does the work at the CGIAR centers relate to African national systems and regional networks?
- How can investments in the national research centers and regional systems be most effective?
- What does the reorganization of the CGIAR system mean for its efforts in Africa?
- How do U.S.-funded Collaborative Research Support Programs (CRSPs) relate to African research systems?
- What are the main barriers preventing the dissemination of agricultural research in Africa?
- What are some approaches to more closely link research with farmers and improve the rate of technology transfer and innovation?
- What is the role of information technology in African research, and can it be used to reliably link researchers in different countries and regions? How can information technology be used to promote sustainable innovation at the farm and herd level?

### Meeting 2, October 25, 2010: Public-Private Partnerships

#### *Speaker:*

**Dr. Emily Twinamasiko**, *Director of Research Coordination, National Agricultural Research Council Secretariat in Uganda; and, Executive Advisory Board member, Water Efficient Maize for Africa (WEMA)*

### *Discussion Questions:*

- What are some key research partnerships—in inputs, technology, finance, and other collaborative efforts—that are having an impact on raising productivity and farmer effectiveness?
- What are some approaches to develop partnerships that do not create competition for funds or competition within U.S. companies?
- What are some approaches for public-private cooperation that will shape long-term partnerships, along with lasting, private sector job opportunities for African scientists?

## **Meeting 3, February 3, 2011: Strengthening the African University System**

### *Speakers:*

**Dr. Samuel Kyamanywa**, *Dean of the School of Agriculture, Makerere University, Kampala, Uganda; and, site coordinator of the Integrated Pest Management (IMP) CRSP in Uganda*

**Dr. Roger Beachy**, *Director, National Institute of Food and Agriculture (NIFA), U.S. Department of Agriculture*

### *Discussion Questions:*

- How can the traditional bilateral cooperation between U.S. and African universities be scaled up or changed to achieve greater impact across the board including helping weaker regions and institutions that need help the most?
- How has the United States supported agricultural research at the university level in Africa in the past? What is the United States currently doing in this area?
- What types of support will be most important in the future to foster African university agricultural research?
- How can emerging and up-and-coming scientists be better engaged in research for direct agricultural use?
- What are the trade-offs between supporting exchanges with U.S. universities and scientists and making lasting investments in African centers?
- How can the United States revitalize its scholarship programs for African scientists? What can African universities do to promote more exchanges and scholarships for scientists within Africa?
- What are some approaches to training and education of researchers that can help create a stronger scientific community in Africa?



## ABOUT THE AUTHORS

**Johanna Nesseth Tuttle** is vice president for strategic planning at CSIS, where she leads the Center's relationships with corporate and foundation supporters. She also directs the CSIS Global Food Security Project, which puts forward policy approaches that can effectively enhance global food security. She authored the project's most recent task force report, *Cultivating Global Food Security: A Strategy for U.S. Leadership on Productivity, Agricultural Research, and Trade* (CSIS, April 2010), and earlier she codirected the task force that produced *A Call for a Strategic U.S. Approach to the Global Food Crisis* (CSIS, July 2008). Nesseth Tuttle regularly participates on panels and speaks to audiences on the subjects of global hunger and food security. She is also an associate with the CSIS Seven Revolutions Initiative, a broad-based effort to forecast key trends, including global resource trends, to the year 2025 and beyond. She has more than 15 years of experience in the nonprofit sector, including work on refugee resettlement issues, voter education, and leadership development and training. Nesseth Tuttle holds an MA in international affairs from the George Washington University, a BA in English literature from the University of Minnesota, and a degree in Portuguese studies from the University of Lisbon.

**Jennifer G. Cooke** is director of the CSIS Africa Program, which she joined in 2000. She works on a range of U.S.-Africa policy issues, including security, health, conflict, and democratization. She has written numerous reports, articles, and commentary for a range of U.S. and international publications. With J. Stephen Morrison, she is coeditor of *U.S. Africa Policy beyond the Bush Administration: Critical Challenges for the Obama Administration* (CSIS, 2009), as well as a previous volume *Africa Policy in the Clinton Years: Critical Choices for the Bush Administration* (CSIS, 2001). Previously, she worked for the House Foreign Affairs Subcommittee on Africa, as well as for the National Academy of Sciences with its Office of News and Public Information and its Committee on Human Rights. Cooke has lived in Côte d'Ivoire and the Central African Republic and speaks French. She earned an MA in African studies and international economics from the Johns Hopkins School of Advanced International Studies and a BA in government from Harvard University.

**Kristin Wedding** is a fellow with the CSIS Global Food Security Project, where she works on policy issues related to enhancing global food security. She coauthored *The Role of Markets and Trade in Food Security* (CSIS, June 2010) and was a contributing author to *Cultivating Global Food Security: A Strategy for U.S. Leadership on Productivity, Agricultural Research, and Trade* (CSIS, April 2010). Wedding is also assistant director for corporate relations in the CSIS Office of Strategic Planning, where she is responsible for managing the Center's relationships with companies in the defense and technology sectors. After joining CSIS in 2005, she served for two years as the research associate in the CSIS Mexico Project, where she analyzed Mexico's domestic politics, U.S.-Mexico bilateral relations, and trade and investment issues. She was a regular contributor to the monthly newsletter *Hemisphere Highlights*, issued by the CSIS Americas Program. Wedding holds

an MA in international political economy from the American University School of International Service, and she earned a BA international relations and Spanish from Florida State University.

**Anna Applefield** does research for the CSIS Global Food Security Project, focusing on policy challenges to global food security. She is also a program assistant in the CSIS Office of Development, where she coordinates and supports CSIS's fundraising efforts. Applefield coauthored *A Market Assessment of Health in Tanzania* (GWU, 2010). She earned an MA in international development with a focus on international health in the Middle East and North Africa from the Elliott School of International Affairs at the George Washington University and holds a BS in psychology from Skidmore College. Applefield has worked on HIV/AIDS issues with high-risk Latin American populations in the United States and rural areas of Peru.





