Pathways to Productivity

The Role of GMOs for Food Security in Kenya, Tanzania, and Uganda

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A Report of the CSIS Global Food Security Project

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Contents

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Executive Summary

East Africa faces tremendous food security challenges. To address the long-term challenges of food production and environmental degradation, the governments of Kenya, Tanzania, and Uganda have decided to explore the use of genetically modified (GM) crops. The U.S. government and other donors have been supportive of these efforts, and have collaborated on research, development, and regulatory efforts to support countries that wish to utilize GM technology. Each of these three countries has developed regulatory frameworks, drafted legislation, and has scientific research underway. As agricultural development grows in prominence as a U.S. development priority, more emphasis is likely to be placed on GM technology as a potential answer to raise productivity, combat environmental challenges, ward off pests and diseases, and ultimately improve the lives of poor smallholder farmers who compose the largest part of the population. Because this technology is prominent and controversial, establishing a clear understanding of dynamics and opinions in each country is important to U.S. policy efforts, and to those of other donors and science collaborators.

This research effort is focused on understanding the debates in each of the countries, and it began with a central question: Can GM crops improve food security among smallholder farmers? The following report examines the status of the debate and development of GM food crops in Kenya, Tanzania, and Uganda, by focusing on the communication and public opinion, the status of the biosafety regulatory structures, scientific and research capacity, and the potential impact on smallholder farmers' food security. The report does not take a position on whether or not countries should adopt the technologies, but instead assesses the experiences of these countries in their unique pursuits of agricultural biotechnology.

There is an enormous need for investments in agriculture in each country, and resources must be focused and maximized on the most promising approaches. There are many other effective interventions that can be implemented to increase food security and agricultural production in the region such as basic mechanization, fertilizer and improved seed adoption, and better irrigation and planting techniques. However, there are three important reasons that governments and donors have chosen to focus on genetic engineering (GE) and biotechnology: one is the potential role it can play in battling pernicious pests and diseases, improving nutrition, and reducing the use of water and chemicals, all of which can benefit farmers and their families. The second reason—especially among agricultural scientists—is that overall scientific progress will be enhanced if scientists have the opportunity to push their research and findings into new areas of discovery. These two goals are underlying reasons for nearly all of the investments and efforts currently underway. Finally, the regulatory structures necessary to permit the research and use of GM crops take many years (between 10 and 12, normally) to develop and codify. For countries that desire to have the ability to utilize GM technology, they must plan for a long lead time. While work continues at the biosafety regulatory policy level, other efforts can address more immediate food security needs.

Following is a short synopsis of the state of the debate and research in each country.

- *Kenya* embarked on the path toward cultivating and regulating genetically modified organisms (GMOs) early, compared to its neighbors. It had a burst of energy on the issue, leading the region in developing a robust regulatory system and building its scientific capacity. But a legal framework alone does not ensure development and commercialization of these crops. Even though it possesses much of the scientific capability and resources, it does not have steady champions within government. Kenya may be better positioned to move toward cultivation and adoption over the long run, but has not had the concentrated focus from government that is needed in the absence of the country's commercial demand.

- *Tanzania* has an uphill battle in adopting the technology, with greater public antipathy toward GMOs and to commercial interests, in general. It has a strong, but comparatively small, scientific community that is feeling frustrated and marginalized and wishes to conduct cutting-edge research and improve food security.

- *Uganda* has in many ways committed to a long incremental approach in developing and adopting GMOs and has trials under way that will still take time before products are commercially available to farmers. Political barriers to adoption are lower than Kenya and Tanzania, in part because its less democratic political structure has facilitated dissemination of a more uniformly positive message on the technology. Nevertheless, key stakeholders engaged in the debate acknowledge there is still a long road ahead as opposition is increasing in the face of concrete biosafety legislation.[1]

In many ways, the GMO debates in Kenya, Tanzania, and Uganda mirror global trends. As the agriculture sector in each country continues to develop, so does the highly polarized debate on GMOs, similar to the strife experienced in the United States and Europe. The absence of commercially available products and significant communication gaps among key stakeholders compound the confusion. Furthermore, there are few individuals with firsthand experience with GM seeds who can serve as strong voices explaining the technology. In the three focus countries, politicians and the public will have to become more engaged with objective scientific evidence that articulates exactly what the technology is, the potential yet still hypothetical risk, and how it might address food security challenges. Ultimately, GMO cultivation in any of the countries—most likely Kenya or Uganda—could have a significant impact in the region. The three countries watch each other closely, and their economies are closely linked. If one moves to commercial production it will be difficult to contain GMO crops within national borders.

[1] Finnigan W. Simbeye, "Tanzania: Government to Endorse GM Maize Trials Soon?," *All Africa*, September 15, 2013, http://allafrica.com/stories/201309150079.html.

1 | Introduction

Food insecurity in sub-Saharan Africa remains a persistent and daunting challenge: 230 million Africans—20 percent of the continent's population—are classified as hungry. The challenge will intensify in coming decades, as Africa's population, currently growing at 2.5 percent annually, is set to double to two billion by 2050.

Critical to meeting the continent's food security needs will be improving the agricultural productivity of African farmers, even as they grapple with climate variability, degradation of soil and water resources, persistent pests and crop diseases, and land constraints. African crop yields lag far behind those in the rest of the world. On average, an African farmer produces 1.3 tons of cereal per hectare—less than half of what a South Asian farmer produces, and a quarter of what a Chinese farmer produces.[1] With nearly 70 percent of sub-Saharan Africans dependent on agriculture for their livelihoods and for household nutrition, boosting the yields of African farmers—in a sustainable way—will have major impacts in driving economic growth, alleviating poverty, and mitigating food insecurity and malnutrition. A doubling of cereal yields on land currently under cultivation in Africa would turn the continent into a major food surplus producer.[2] Smallholder farmers—those with less than two hectares of land—will need to be at the heart of this transformation, given that they currently constitute some 80 percent of the continent's agricultural work force and provide 90 percent of the continent's food supply.[3]

The urgency of immediate needs and a growing awareness of the looming challenge have led a number of African governments to consider the potential benefits of biotechnology—and in particular genetically modified (GM) crops[4]—to increase yields, decrease reliance on costly inputs, reduce labor, and bolster resistance against specific diseases and pests. These governments have looked to a growing body of research that points to the potential benefits of GM technology[5] and to the growing number of

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[1] In the developed world, crop yields are around six times those of Africa. See Gordon Conway, *One Billion Hungry: Can We Feed the World?* (Ithaca, NY: Cornell University Press, 2012).

[2] Kwadwo Asenso-Okyere and Samson Jemaneh, "Increasing Agricultural Productivity & Enhancing Food Security in Africa: New Challenges & Opportunities," International Food Policy Research Institute, March 2012, http://www.ifpri.org/sites/default/files/publications/oc71.pdf.

[3] Angela Mwaniki, "Achieving Food Security in Africa: Challenges and Issues," Office of the Special Adviser on Africa, United Nations, http://www.un.org/africa/osaa/reports/Achieving%20Food%20Security%20in%20Africa-Challenges%20and%20Issues.pdf.

[4] Genetically modified (GM) foods are foods derived from organisms whose genetic material (DNA) has been modified in a way that does not occur naturally (e.g., through the introduction of a gene from a different organism). Currently available GM foods stem mostly from plants, but in the future foods derived from GM microorganisms or GM animals are likely to be introduced on the market. Most existing genetically modified crops have been developed to improve yield, through the introduction of resistance to plant diseases or of increased tolerance of herbicides. See World Health Organization, "Food, Genetically modified," http://www.who.int/topics/ food_genetically_modified/en/.

[5] For example, a study by the International Food Policy Research Institute concluded that under ideal conditions the use of GM commercial crops grown by smallholder farmers could improve gross margins by 114 percent, reduce pesticide costs by 60 to 90 percent, and improve yields by 18 to 29 percent. See African Development Bank (AfDB) and International Food Policy Research Institute (IFPRI), "Assessment of Agriculture Biotechnology for Africa," AfDB-IFPRI Stakeholders Consultation Meeting on Agricultural

emerging markets—Brazil, India, China, Argentina, South Africa, Chile, and Mexico—that are growing commercial genetically engineered (GE) crops.[6] As the promises of transgenic technologies gain profile, as African economies diversify their trade partners beyond Europe and the United States, and as fears around possible health risks abate, a growing number of African countries have begun to invest scientific, financial, and political resources to examine how GM technology might address their unique food security needs.[7] See table 1 for an overview of GM crops being developed and tested in Kenya, Tanzania, and Uganda.

There are nonetheless major barriers to be overcome. Over the last two decades, debates in Africa around transgenic technologies have been mired in controversy. The African science and research community has struggled to communicate the benefits of these new technologies, meaning that these discussions have been, to a large extent, driven and dominated by non-African interests, and infused with polemical and often exaggerated claims on both the benefits and risks of the technology. In reaction to the controversies, the default position of many African states has been flatly prohibitive or at a minimum highly precautionary. Today, only three countries in sub-Saharan Africa produce GM crops for commercial use. South Africa began producing Bt cotton in 1997; Burkina Faso followed suit in 2008, and Sudan in 2012.[8] South Africa alone produces transgenic food crops—the majority of its soya and maize crops are genetically modified. The residual effects of those highly polarized debates are still palpable and there remains considerable resistance—not all of it well-informed—to the adoption of the technologies.

Even the most ardent proponents of transgenic solutions are up front about the role that genetic modification can play in African agriculture. It is not a silver bullet for increasing productivity or improving food security in Africa, but it is a tool that can enable farmers to boost productivity while also tackling persistent problems, including pests and diseases that can destroy an entire crop. Within this context, a first and central challenge is that to have an impact on food security and livelihoods, GM seeds must be relevant to the needs of African smallholder farmers, whose needs and local environments vary tremendously among and within different African states. Many of the sustained challenges farmers face stem from limited access to the most basic agricultural inputs. The majority of African farmers do not have adequate fertilizer and seed systems are often dysfunctional: reliable seeds are expensive or hard to come by, and counterfeit seeds are widely sold. It is estimated that less than 30 percent of farmers in sub-Saharan Africa use any type of improved seeds (including both hybrids and newer open-pollinated varieties) that have been developed through conventional breeding.[9] Extension services to disseminate new technologies and agricultural practices have

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Biotechnology in Africa, 2011, http://www.afdb.org/en/news-and-events/article/afdb-ifpri-stakeholder-consultation-meeting-on-agriculture-biotechnology-in-africa-8814/.

[6] Clive James, *Global Status of Commercialized Biotech/GM Crops: 2012*, ISAAA Brief 44-2012 (Ithaca, NY: International Service for the Acquisition of Agri-biotech Applications, 2012), https://www.isaaa.org/resources/publications/briefs/44/default.asp.

[7] Four African countries have commercialized biotech crops: South Africa, Burkina Faso, Egypt, and Sudan. South Africa is by far the largest producer, planting 2.9 million hectares. Five countries have conducted field trials (CFTs) of biotech crops: Cameroon, Kenya, Malawi, Nigeria, and Uganda. CFTs are the second-to-last step in approval for commercialization. See James, *Global Status of Commercialized Biotech/GM Crops: 2012*.

[8] Although cotton is not thought of as a food crop, it can be used as fodder and in producing cottonseed oil.

[9] Food and Agriculture Organization of the United Nations (FAO), "Rebuild small seed enterprises," March 1, 2011, http://www.fao.org/news/story/en/item/51581/icode/.

Table 1. Overview of GM Crops Developed and Tested in Kenya, Tanzania, and Uganda

Country	Crop	Trait	Institutions Involved	Stage of Development	Estimated Release Date
Kenya	Corn	Drought tolerance/water efficiency (Water Efficient Maize for Africa)	KARI, AATF, CIMMYT, and Monsanto	Three confined field trials (CFT) completed at KARI Kiboko; fourth season about to be planted	2018
		Insect resistance	KARI, AATF, CIMMYT, and Monsanto	First CFT season about to be planted	2025
		Drought tolerance	Kenyatta University and ASARECA	Contained use (greenhouse experiments)	2030
	Cotton	Insect resistance (bollworms)	KARI and Monsanto	Fifth CFT completed; awaiting submission of application for commercial release	2015
	Cassava	Virus resistance	KARI and DDPSC	One CFT season completed	2017
		Biofortified with increased levels of iron, zinc, protein, vitamin A, and vitamin E	DDPSC, KARI, IITA, and CIAT	One CFT season completed	2018
	Sorghum	Biofortified with increased levels of iron, zinc, vitamin A, and vitamin E	KARI, AHBFI, DuPont Business, and Pioneer Hi-bred	Greenhouse experiments concluded. CFT approved by NBA	2020
	Sweet potatoes	Insect/weevil resistance	CIP and Kenyatta University	Laboratory and greenhouse transformation approved by NBA in April 2011	2020
		Viral diseases	KARI, Monsanto	One CFT season completed	
	Pigeon peas	Insect resistance	Kenyatta University	Lab and GH transformation approved by NBA	
Uganda*	Corn	Drought tolerance	NARO, AATF, Monsanto	Second CFT season completed	2017
		Insect resistance	NARO, AATF, Monsanto	First CFT season completed	2015
	Bananas	Bacterial wilt resistance	NARO, AATF, IITA	One CFT cycle completed. Repeat cycle planted 2013	2018
		Enhanced micronutrients (vitamin A)	NARO, Queensland University of Technology	Three CFT cycles completed	2021
		Nematode resistance	NARO, IITA, Biodiversity International University of Leeds	One combined (four gene technologies) planted	2020
		Black sigatoka and fusarium wilt resistance	NARO, Venganza	Greenhouse evaluation of transgenic lines underway	2025

	Cassava	Viral resistance	NARO, DDPSC, IITA	Second CFT season completed	2018
	Cotton	Insect resistance and herbicide tolerance	NARO, Monsanto	Third CFT season completed	2015
	Irish potato	Late blight resistance	NARO, CIP	Greenhouse experiments and first trial planned for 2014	2025
	Sweet potatoes	Weevil resistance	NARO, CIP	Contained GH trials	2025
	Rice	Nitrogen use efficiency and salinity resistance	NARO, AATF, Acadia Bioscience	First CFT completed	2016
Tanzania	No GM crops under development				

**There is not an official release date for commercial GM crops in Uganda as their biosafety law has not yet been enacted. However, it is anticipated that the first crops could be released as early as 2015.*

Note: KARI = Kenya Agricultural Research Institute; AATF = African Agricultural Technology Foundation; CIMMYT = International Maize and Wheat Improvement Center; ASARECA = Association for Strengthening Agricultural Research in Eastern and Central Africa; DDPSC = Donald Danforth Plant Science Center; IITA = International Institute of Tropical Agriculture; CIAT = International Center for Tropical Agriculture; AHBFI = Africa Harvest Biotech Foundation International; NARO = National Agricultural Research Organization; CIP = International Potato Center.

Sources: Carol N. Kamau and Brian Dutoi, *Agricultural Biotechnology Annual 2013 Kenya Agricultural Biotechnology Report*, USDA Global Agricultural Information Network, July 2013, http://gain.fas.usda.gov/Recent%20GAIN%20Publications/Agricultural%20Biotechnology%20Annual_Nairobi_Kenya_7-15-2013.pdf; John Komen David Wafula, *Trade and Tribulations: An Evaluation of Trade Barriers to the Adoption of Genetically Modified Crops in the East African Community* (Washington, DC: CSIS, April 2013), 5, http://csis.org/files/publication/130419_Komen_TradeTribulations_Web.pdf.

Uganda data: Andrew Kiggundu, e-mail to author, October 7, 2013.

Data from: International Service for the Acquisition of Agri-biotech Applications (ISAAA), 2012 Biotech Update; C. James, *Global Status of Commercialized Biotech/GM Crops: 2011*, Brief 43 (Los Baños, Philippines: International Service for Acquisition of Agri-biotech Applications).

remained weak and in many countries have declined since the 1960s and 1970s. Mechanization and access to credit or crop insurance are largely aspirational. Most farmers lack adequate storage facilities and are unable to get their crops to market because of enormous infrastructure deficits. Therefore, for many African smallholder farmers GM crops are largely an abstract concept and do not figure among their most pressing priorities.

The challenges of developing and commercializing GM crops to benefit African smallholder farmers are multiple, even in those countries in which the senior political leadership has demonstrated openness to the technologies. A central challenge is the absence of a strong demand-pull from the end user (the smallholder farmer) for GM food crops. In other African countries where products are less abstract, like Bt cotton, a demand-pull does exist, but this is yet to be seen for GM food crops in East Africa. Therefore, the great burden of sustained, consistent drive and investment—in public communication, legislative and regulatory frameworks, research and development capacity, dissemination and training, regional regulatory and trade harmonization—will fall on the public sector. Private-sector research and development has been a major driver of GM technology in much of the world, but the end products of commercialized research have rarely been tailored to the needs of low-income, smallholder farmers or the crops on which they rely. A major question for those countries that seek to develop locally relevant GM crops is whether the government leadership, together with the

science establishment, can generate and sustain political will and momentum on GM research and development in the face of competing priorities, public resistance (or at least ambivalence), and an uncertain uptake by the eventual end user.

Illustrating these challenges, this report offers an examination of the status of debate and development of GM crops in three East African countries—Tanzania, Kenya, and Uganda. All three countries have been hard hit by the effects of climate variability, periodic pest and disease infestation, and cyclical bouts of food insecurity. The senior political leadership in all three has been open to exploring the possibilities and potential of GM technologies. All three governments have made a deliberate decision to develop research and regulatory capability to utilize the technology in scientific settings and determine what role GMOs should play within the broader national agricultural strategy. And all three countries have economies and trade patterns closely linked through the East African Community regional customs union and common market. Notwithstanding these areas of commonality, the three countries have had very different experiences in the pursuit and development of GM technologies.

Based on a series of field visits and interviews in Kenya, Tanzania, and Uganda in the course of 2012–2013, this report provides an assessment of the status of debate and progress on GM technologies in each of the three countries, seeking to identify the major areas of challenge and promise in the long process of regulation, development, dissemination, and eventual commercialization of GM crops—as well as the possibilities of adoption and use by smallholder farmers. In each country, the report examines communication and public opinion around GMOs; the evolution of biosafety and regulatory structures; the state of science and research capacity; and the role of smallholder farmers in current debates and strategies. The report does not take a position on the ultimate benefits or risks of GM technologies, nor does it take a position on whether the focus countries should adopt the technologies.[10] Rather, it seeks to highlight the experiences in these three countries, identify the drivers of debate, and offer thoughts on how the development and dissemination of GM crops may play out in future. Ultimately, CSIS's primary objective is to offer points of consideration as countries contemplate GM adoption and offer recommendations on how best to support those governments who are interested in applying new technologies to their agricultural capacity.

Main Observations

During field studies in each of the focus countries, a number of common observations and themes emerged.

GMO Debate

- Most scientists, policymakers, and development experts acknowledge that GMOs could potentially have a significant impact in addressing specific challenges,

[10] This project is framed within the context of how GMOs might impact smallholder farmers' food security. It does not conduct an in-depth analysis of the potential commercial uses and impacts for GM crops in aggregate at the national or regional levels. The challenges and impacts to adoption, cultivation, and selling GM food crops are understood to be different, though related, for smallholder farmers and large-scale commercial producers.

including: improving productivity, combating crop diseases, enhancing the nutritional content of food, and mitigating impacts from climate change.

- The nature of GMO research and regulation is distinctly reflective of each country's local context and governance system, though opinions tend to follow the same trends as the global debate, in part due to the fact that both research initiatives and opposition groups are often funded by European and U.S. NGOs and governments.

- For GMOs to make an impact in the region, scientists, businesses, policymakers, and other interested parties need to work on the supply side. Only by working on supply—getting products on the market—will demand grow.

- Political will matters. Because this is a niche issue among African policymakers and in the absence of a strong demand signal from farmers, a political champion is required to see the issue through the government and legislature. It significantly impacts broader attitudes toward GMOs, along with ongoing and future GM research, development, adoption, and commercialization.

- Sustaining momentum on GM development and regulation will be difficult in the face of sustained opposition from a small constituency of highly engaged activists, bureaucratic inertia or ambivalence, and long-wait time as products move through the testing process. Countries that do wish to pursue GM should be prepared for a long process that requires sustained effort from a host of different constituents.

Investment in Agricultural Delivery Systems Is Essential

- Even in the event of successful commercialization, poor agricultural infrastructure and the lack of effective channels to disseminate technology to smallholder farmers is an overarching challenge. The large majority of smallholder farmers have not adopted basic existing technologies and practices. Extension systems remain chronically weak and could dampen any potential impact of GM crops should a country choose to adopt them. New and creative approaches to extension and agricultural education are needed.

- The seed sector in each of the countries is weak, underdeveloped, cannot meet current demand, and is often infiltrated with counterfeit products. This lack of capacity would diminish potential positive returns from GM adoption.

Regulatory Capacity

- Bureaucracy matters. The institutional structure that governs agricultural research, agricultural policy, and biosafety plays an important role in advancing research and implementation. In Tanzania, the divisions and lines of authority around biosafety issues have created occasional tensions and jurisdictional uncertainties. On the other hand, in Uganda, governing structures around biosafety have been generally harmonized, with an early and consistent consultative process within government and greater consensus on the balance to be struck between biotechnology promotion and biosafety precaution.

- The particular focus of each regulatory system has an important bearing on the potential for development and adoption. In Uganda, the environment is enabling and

communications are quite uniform; in Kenya, it is robust, but potentially limiting and subject to political intervention; and in Tanzania, it is more restrictive.[11]

Scientific Capacity

- African scientists and research institutions are keen to drive the development of relevant transgenic technologies within their respective countries and throughout the region. Within the scientific establishment in each country visited, there is a sense of pride in the local advances in biotechnology and an eagerness to harness science to solve national and regional food security and development challenges. But many within the research establishment say that they need to do a better job of educating the public and policymakers on what genetic modification entails and more effectively communicate the benefits and possible risks.

- African researchers are adapting donated or royalty-free licensed genes from private companies and public entities for relevance and preference within their individual countries. People remain skeptical over the potentially influential role that multinational companies might have as owners of the technology. Ownership over the intellectual property remains a major concern. However, in each country, research and GM seed development is the purview of the government, and all resulting products are designated for public use and will ultimately be owned and licensed by the government and made available to local seed companies at no additional costs.

Smallholder Farmers

- There has been little systematic study of smallholder attitudes toward GMOs in Africa, and because GMO products have not yet become publicly available, the possibilities of GM crops remain largely an abstract concept. One view, expressed by a senior official at the Ugandan Science Foundation for Livelihoods and Development, is that "farmers are open to options as long as they work, and as long as it gives some value added."[12] But without a product available to make that calculation, there is no strong demand signal from smallholder farmers for the technologies, and other pressing priorities at present take precedence.

- Farmers will need good products and information in order to shift to using GM crops. Subscription-based services, enhanced extension efforts, and community-based farm leaders may be able to fill the role of trainers and educators.

Regional and Trade Dynamics

- Although significant work is being conducted by a small group of experts through regional bodies, such as the East African Community (EAC) and Common Market for East and Southern Africa (COMESA), national policies and decisions will likely shape regional regulation of GMOs. Nonetheless, as Uganda and Kenya move toward

[11] For additional information on the biosafety regulatory systems, see Judith Chambers, *Biosafety of GM Crops in Kenya, Uganda, and Tanzania: An Evolving Landscape of Regulatory Progress and Retreat* (Washington, DC: CSIS, forthcoming).
[12] Author interview with Arthur Makara.

possible commercialization, the EAC will need a more harmonized framework for export, trade, and biosafety regulation within member countries.

- Successful commercialization of GMO crops by one of these countries could accelerate adoption in the region, as farmers and policymakers gain more tangible evidence of the possible benefits and drawbacks.

- There is a fear that commercialization of GM food crops by EAC countries could negatively impact export markets. However, when analyzing trade data of GM crops under development (maize, cotton, and cassava), there is little evidence that commercialization would pose significant trade losses, as the majority of these crops are staple food products traded intra-regionally, not internationally.[13]

[13] For a detailed analysis, see John Komen and David Wafula, *Trade and Tribulations: An Evaluation of Trade Barriers to the Adoption of Genetically Modified Crops in the East African Community* (Washington, DC: CSIS, April 2013), http://csis.org/files/publication/130419_Komen_ TradeTribulations_Web.pdf.

2 | Country Case Studies

Kenya

Kenya is a robust democracy with diverse constituencies; its debate over GMOs reflects the Kenyan political structure. Kenya has been the most active of this study's three countries in developing a regulatory structure and advancing the research. It currently has confined field trials (CFTs) underway in cassava, maize, sorghum, and cotton. The regulatory structure is well developed and serves as a model for others in the region; the legal structure is firm; and the research is advancing. However, although the system is advanced, the potential for long-term use is somewhat questionable, because the methods for distributing seeds and information are weak and the entire regulatory system is subject to political whims. Last fall, the minister of health declared a ban on all GM products, including food aid, despite her lack of jurisdiction. This decision is indicative of the role that politics and personalities will have in the progress or slowing of GM research and approvals in Kenya. Furthermore, passage of the regulatory legislation requires sustained energy and complicated negotiations, which has left a sense of exhaustion among key political players. In Kenya, few people have absolute authority; as a result, a diverse coalition will be necessary to advance this issue.

Regulatory System

Kenya's biotechnology regulatory system has been a priority of the government for many years and, as a result, is among the most sophisticated and well supported in Africa. Biotechnology was originally overseen by the National Council for Science and Technology (NCST). However, the National Biosafety Authority (NBA), under the Ministry of Higher Education Science and Technology, now regulates GMOs. NBA's senior management has been in place since February 2012.

Between September 13, 2011, and May 11, 2012, the NBA approved 27 genetically modified products for imports and transit. All of the approved products were for humanitarian assistance or food aid transit through Kenya. Currently research is underway in four food crops: maize, cassava, sorghum, and sweet potatoes. Cotton is expected to be the first commercially released crop and is anticipated to be available in 2014–2015.[14] Refer to table 1 for a detailed overview of GM crops currently under development in Kenya.

Rules on GMO labeling are controversial. In May 2012, Kenya passed a regulation requiring food products that meet or exceed a GMO content of at least 1 percent be labeled as such. The financial and legal repercussions for breaking this regulation are steep: a fine up to 20 million KES (~US$240,000) and/or up to 10 years in jail. Stakeholders largely view this strict labeling requirement as a tacit opposition to GM food production by some key decisionmakers within the government. Not only are the

[14] Carol N. Kamau and Brian Dutoi, "2013 Kenya Annual Biotechnology Report," USDA Foreign Agricultural Service, Global Agricultural Information Network, July 15, 2013, http://gain.fas.usda.gov/Recent%20GAIN%20Publications/Agricultural%20Biotechnology%20Annual_Nairobi_Kenya_7-15-201.pdf.

requirements onerous and costly, they are nearly impossible to enforce because much of the food comes in bulk from open-air markets, rather than in packages from grocery stores. Furthermore, it sends potential producers a clear signal that there is not a commercial market for GM products within Kenya. Still, many stakeholders, including some at the NBA, have noted that because the labeling requirement is a regulation and not a law, it could be changed with the approval of the minister of higher education science and technology alone, and would not require approval by the Parliament and prime minister.

Despite the NBA's role as a neutral arbitrator, political forces clearly impact decisions on GMOs. Although Kenya's GM monitoring and regulatory system is impressive, it is easily bypassed through political influence. In November 2012, Kenya's Public Health and Sanitation Minister Beth Mugo, who did not have jurisdiction over the issue, announced a ban on all GMO food products, including any potential food aid, in order to conduct additional research on to the products' safety. This ban was allegedly in response to a widely discredited study led by French scientist Gilles-Eric Séralini, which claimed GM maize causes severe disease in rats.[15] In effect, the Kenyan government disregarded its own biosafety experts and regulatory authority and issued the Kenyan Cabinet and Presidential decree without going through the proper channels established in the 2009 Biosafety Act.

According to one biotechnology scientist at Kenyatta University in Nairobi, "the essence of GMO research is to provide a product that can complement efforts towards food security. This ban will discourage research, as the product for which the research is being conducted has been placed on import ban."[16] Should Kenya need to import maize in order to cover a domestic production deficit or for emergency aid, this ban will likely be problematic. Since the ban's limits have not yet had sufficient reason to be tested, it is difficult to know how the newly elected leadership will choose to enforce or repeal it.

Science and Research Capacity

Despite the recent ban on GMO foods, research on the technology remains robust in Kenya. GM scientific research in the country began over a decade ago. Coupled with Kenya's sophisticated scientific community, they have made a fair amount of progress. However, the Kenyan scientific community experienced a long period without sufficient funding and is somewhat demoralized as a result. Still, a large cadre of scientists conducts research in both the national research system and privately funded organizations. The Kenya Agricultural Research Institute (KARI) is the leading organization conducting research on GM crops. KARI often partners with other research institutions and international donors. The organization anticipates releasing Bt cotton commercially in 2015, followed by Bt maize in 2018.

Kenya, in addition to Tanzania, Uganda, South Africa, and Mozambique, participates in the Water Efficient Maize for Africa (WEMA) partnership (see text box on following page for details on the WEMA project). KARI is currently conducting confined field trials of the

[15] Declan Butler, "Hyped GM maize study faces growing scrutiny," *Nature* 490, issue 7419 (October 11, 2012), http://www.nature.com/news/hyped-gm-maize-study-faces-growing-scrutiny-1.11566.
[16] Otieno Owino, "Scientists torn over Kenya's recent GM food ban," SciDevNet, November 30, 2012, http://m.scidev.net/sub-saharan-africa/nutrition/news/scientists-torn-over-kenya-s-recent-gm-food-ban-1.html.

Water Efficient Maize for Africa (WEMA): A Partnership for Food Security

Water Efficient Maize for Africa (WEMA) is a public-private partnership established in 2008 that works to improve food security in sub-Saharan Africa by developing and distributing drought-tolerant maize using modern plant-breeding methods, royalty-free to smallholder farmers. WEMA is being implemented in five countries: Kenya, Mozambique, South Africa, Tanzania, and Uganda. The project is led by the African Agricultural Technology Foundation (AATF), and the partners include the International Maize and Wheat Improvement Center (CIMMYT), Monsanto, and the national research organizations: Kenya Agricultural Research Institute (Kenya), Instituto de Investigação Agrária de Moçambique (Mozambique), Agricultural Research Council (South Africa), Commission for Science and Technology (Tanzania), and National Agricultural Research Organization (Uganda). The project is funded in part by the Bill and Melinda Gates Foundation, the Howard G. Buffett Foundation, Monsanto, and USAID.

The project is in its sixth year and is approaching a significant milestone as the first WEMA conventional maize hybrid will be available for commercial planting in Kenya by 2014. In addition to Kenya, Uganda and South Africa also have confined field trials of the GM variety underway. The project is taking a three-pronged approach to addressing the drought challenge: using conventional breeding to produce new varieties; undertaking discover breeding to find genes that confer drought tolerance in the maize genome; and transferring GM into adapted varieties in the partner countries. The goal is that these products will be drought-tolerant and give a minimum of 25 to 30 percent yield during drought conditions comparable to hybrids produced in 2008. During trials, one of the key challenges to the success of the drought-tolerant varieties has been from insects, primarily maize stem borers. To mitigate the harmful pest threats, the project is adding insect-protection complimentary and will also be available royalty-free. This increased yield stability has the potential to help reduce hunger and improve the livelihood of millions of Africans.

Depending on research results in each of the WEMA countries, the partners expect a pipeline of new drought-tolerant hybrid varieties to be ready for the subsequent season in several countries. This will give smallholder farmers the first chance to plant high-quality drought-tolerant hybrids on their farms. Within a few years, pending regulatory approval, they expect to introduce and deliver royalty-free insect-protected and drought-tolerant maize varieties to smallholder farmers in Africa to manage risk and increase food security.

Sources

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Monsanto. "Water Efficient Maize for Africa (WEMA)." http://www.monsanto.com/improvingagriculture/Pages/water-efficient-maize-for-africa.aspx.

drought-resistant maize at their Kiboko site. Bt maize, which is being developed in conjunction with drought-tolerance traits under the WEMA project, is scheduled for release in Kenya in 2018, and in Uganda, pending legislation. These products will be licensed publicly by government and sold by private companies operating in Kenya.

Many researchers articulated the challenges of finding and maintaining funding for agricultural biotechnology research. Although KARI hosts some of the most significant biotech research projects in Kenya, this is only possible in collaboration with other

groups and donors. There is a significant benefit from piggybacking on research and science done elsewhere, as it enables site-specific research to advance more quickly, particularly where national partners lack the capacity or facilities to do the genetic transformation locally. For example, research on virus-resistant cassava is being done in collaboration with the Donald Danforth Plant Sciences Center in St. Louis, Missouri, and a variety of national and international research institutes in Uganda and Kenya.[17] Gene transformation to improve cassava resistance to two particularly devastating viruses—cassava brown streak disease (CBSD) and cassava mosaic disease (CMD)—was conducted at the Danforth Center along with some of the initial greenhouse work. Confined field trials are underway in Uganda and Kenya in varieties that could easily be transformed to local varieties once they are able to establish the efficacy of the traits in the real world. Royalty-free improved planting materials will be made available to farmers. Furthermore, the Virus Resistant Cassava for Africa (VIRCA) project serves to build scientific capacity and collaboration on biotechnology in EAC countries.[18]

While there are financial resources from collaborative partnerships, Kenyan scientists expressed frustration regarding the low level of national funding devoted to science, noting that the Kenyan government needs to make more serious investments if they are to make large gains in research. In January 2013, then-President Mwai Kibaki signed the Science, Technology, and Innovation Act, establishing a National Research Fund, which receives 2 percent of the country's annual GDP.[19] Since current science funding is at 0.48 percent of GDP, scientists hope this could spur much needed investment in research and development in the agriculture sector.[20]

Communication and Public Opinion

The debate over biotechnology in Kenya, especially at the scientific and political levels, has taken place over many years. Scientists, high-level government agriculture officials, and commercial farmers are generally receptive to the technology. Public opinion shifted as activists against research and planting of crops diminished, but a new focus has since emerged around labeling requirements.

There is still limited knowledge about GM crops across many parts of society, including consumers, politicians, the media, and—importantly—smallholder farmers. Considering that one-quarter of Kenya's GDP and three-quarters of its population rely on agriculture, there is much at stake. Many people caution that they have heard about the promises of GM crops for years and are now exasperated with the debate as no product has yet been released to farmers. Although Kenya devoted significant resources to developing a biotechnology regulatory structure, the debate will remain largely theoretical until there is a product on the market.

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[17] VIRCA partners include Donald Danforth Plant Sciences Center (United States), National Crops Resources Research Institute (Uganda), KARI (Kenya), International Institute of Tropical Agriculture (Kenya), Science Foundation for Livelihoods and Development (Uganda), and International Service for the Acquisition of Agri-biotech Applications–AfriCenter (Kenya).

[18] Nigel J. Taylor et al., "The VIRCA Project: Virus resistant cassava for Africa," *GM Crops and Food: Biotechnology in Agriculture and the Food Chain* 3, no. 2 (2012): 93–103, https://www.landesbioscience.com/journals/gmcrops/article/19144/.

[19] Republic of Kenya, "The Science, Technology, and Innovation Bill, 2012," Kenya Gazette Supplement No. 122, http://cipitlawstrath.files.wordpress.com/2013/02/ thesciencetechnologyandinnovationbill2012.pdf.

[20] "Kenya's Presidential Candidates 'Failing to Prioritise Science,'" AfricanBrains, March 4, 2013, http://africanbrains.net/2013/03/04/kenyas-presidential-candidates-failing-to-prioritise-science/.

There is a need for increased public dialogue on GMOs, as there is still a fair amount of uncertainty over the safety of the technology among the general public, smallholder farmers, and some politicians. The press in Kenya is sophisticated, yet it disseminates inaccurate information about GMOs. It is essential to promote balanced and accurate media coverage of this issue because as more people are exposed to it, the more likely they are to understand it and determine informed preferences for their farms and goods they purchase.

In many ways, the debate is limited to elite scientific and government circles. As one interviewee said, "the argument has become irrelevant because the converted are preaching to each other." Additionally, the protocols for the CFTs might inadvertently spark fear. In many cases, these trials require large fences or moats around crops, or for the crops to be burned following the trials. This unintentionally can instill fear in the public, and farmers may wonder why these precautions are necessary if the plants are safe.

Ultimately, communication and information will not be credible unless it comes from African voices, particularly credible scientists, government officials, and journalists with knowledge of the research and development efforts. The Open Forum on Agricultural Biotechnology (OFAB) is one such effort underway. OFAB has active groups in Burkina Faso, Ghana, Kenya, Nigeria, Tanzania, and Uganda and seeks to increase public dialogue and understanding of a variety of agricultural technologies. (For additional information on OFAB, see text box on following page.)

Smallholder Farmers

CSIS researchers spent the day with a group of 15 smallholder farmers in Nyanza Province of western Kenya. Unlike the majority of farmers, this group works with One Acre Fund, a nonprofit organization operating in East Africa to raise smallholder farmer income by providing them with comprehensive services including farm inputs on loan, seed, and fertilizer delivery within walking distance, training on how to properly use farm inputs, and harvest marketing assistance. Since these farmers enrolled in a program and currently use loans to purchase seed and fertilizer, they already experience increased yields and benefits from changing their farming methods and are more likely to adapt to new kinds of seeds than independent farmers.

Through discussion and observation it was clear that no type of seed—GMO, hybrid, or conventional—has much more of a chance to improve food security for the typical farmer without an intense extension, education, and financing effort. But for many farmers, especially those outside the network of groups like One Acre Fund, government extension is woefully insufficient in providing even the most basic level of training or access to inputs. A chief complaint was that with each growing season, they receive insufficient, and usually inferior, seeds and fertilizer. They rarely receive information on farming practices, diseases, and other important information. The sporadic information they get generally comes from the government or local media via the radio and from neighbors.

When asked about GMOs, most of the farmers had heard of them but did not know their purpose or use. They asked questions regarding GM products' safety and how to increase their farms' productivity. Ultimately, the group agreed that if the government deemed

Communication and Public Engagement on Biotechnology: Open Forum on Agricultural Biotechnology in Africa (OFAB)

The Open Forum on Agricultural Biotechnology in Africa (OFAB) is a platform that brings together stakeholders in biotechnology and enables interactions among scientists, journalists, the civil society, industrialists, lawmakers, and policymakers. It is modeled around structured monthly meetings that provide opportunities for key stakeholders to interact, share knowledge and experiences, make new contacts, and explore new avenues of bringing the benefits of biotechnology to the African agricultural sector. OFAB aims to disseminate credible, quality research and information on biotechnology and genetic engineering (GE) to interested parties, including farmers, consumers, and politicians.

OFAB has chapters in six countries: Burkina Faso, Ghana, Kenya, Nigeria, Tanzania, and Uganda. It partners with the African Agricultural Technology Foundation (AATF), International Food Policy Research Institute's (IFPRI) Program for Biosafety Systems (PBS), National Biotechnology Development Agency (NABDA), Tanzania Commission for Science and Technology (COSTECH), International Service for the Acquisition of Agri-biotech Applications (ISAAA), Uganda National Council for Science and Technology (UNCST), Agricultural Research Council of Nigeria (ARCN), and Council for Scientific and Industrial Research.

The first OFAB chapter was launched in Nairobi, Kenya, in September 2006. A collaborative initiative between AATF and ISAAA Africenter, the Kenyan chapter paved way for the launch of two other chapters in Africa.

The Uganda chapter was launched in December 2007 and is a collaborative venture among AATF, UNCST, and PBS/IFPRI.

The Tanzania chapter was launched in May 2009. The chapter is hosted by COSTECH, in collaboration with AATF.

GMOs safe, then they would feel comfortable using them, provided they could access the seed and necessary inputs.

Forecast for Adoption

The private sector and commercial farmers, who generally provide a demand-pull for new products, have an important role to play in Kenya's movement toward commercialization of GM food crops. Still, companies are not inclined to introduce biotechnology products for a number of reasons. One factor is regulatory uncertainty; if Kenya's health ministry can overturn a regulatory decision, there is not sufficient assurance to make investing in marketing new varieties worthwhile. Second, the rise in demand for GM-free standards by domestic and international retailers and consumers creates even more uncertainty. Producers are understandably hesitant to produce both GM and non-transgenic varieties while the two must be completely separated. This is compounded by the fear that there will be limited demand for goods produced with GM materials. For example, some of Kenya's export market countries require horticultural products and cash crops (like coffee and tea), which have no transgenic variety, to be labeled as GM-free. Finally, the stringent label requirements and penalties for noncompliance disincentive the cultivation of GM varieties. As Diamond Lalji, the chairman of the Cereal Millers Association, explains, "we are reluctant to import GMOs.

Mandatory labeling requirements make the products less attractive. Labeling GMO products creates an impression that they were not safe."[21]

Developing varieties for a Kenyan market would be expensive and without the legal framework and harmonization to sell new varieties beyond Kenyan borders, investment in the development of new GM crops will be limited to government efforts.

However, with trials nearing completion and commercialization of cotton anticipated in 2014–2015, as well as with focused efforts on developing seed systems in Kenya, it is reasonable to expect that forthcoming products may push forward demand and open new potential for adoption. It may be that larger farmers lead the demand, but that groups such as One Acre Fund and others working with farmers become the conduit for new varieties and for the information farmers will need to utilize them.

Tanzania

At the highest levels of the Tanzanian government, leaders have equivocally supported GM technology. Many of the people we interviewed indicated that the President Kikwete and some cabinet ministers support the technology. However, their public support has wavered in the face of internal political opposition, particularly from the Environmental Ministry, which has inhibited movement in regulatory and research efforts. In addition, the thick bureaucracy that hampers quick movement on any issue in Tanzania is likely to be both a real stumbling block and an easy political scapegoat for those who want to keep the status quo. The bureaucracy may push up against the president's agenda; he has committed to an ambitious agenda of economic growth and development, which will be led by agriculture and will require a strong agribusiness sector.

As a major recipient of American and foreign donor assistance, Tanzania faces a great deal of external pressure to relax its restrictive approach to biotechnology, in part because biotechnology policy serves as a signal of openness to external investment and seriousness about growing the agriculture sector. Tanzania is distinct from its neighbors in many ways. Of the three, it is the country that has the greatest international attention on agriculture. Not only is it a Feed the Future country (like Kenya and Uganda), but it stands apart from the other two as a Partnership for Growth country, a Millennium Challenge Corporation country, and one of the New Alliance for Food Security and Nutrition countries. All of these programs, accompanied by funds and requirements from the United States and other donors, are designed to build out agriculture systems in partnership with the local private sector and major multinational corporations. Yet Tanzania is the most hesitant and aloof to the debate on biotechnology and, to a large degree, to the engagement of multinational companies in its economy. Historically, Tanzania has been very cautious toward biotechnology, passing the strictest possible regulations for its adoption. In the face of pressure from the American donor community, Tanzania has carefully expressed willingness to relax those regulations, which has resulted in political infighting. As of yet, the debate largely exists in the government. Tanzania will be under pressure to change current policies toward engagement of biotechnology as part of broader agricultural development investments.

[21] Komen and Wafula, *Trade and Tribulations*, 23.

Regulatory System

Tanzania's biotechnology regulatory system is among the most restrictive and precautionary in Africa. Regulations call for strict liability, as opposed to the fault-based liability that both Kenya and Uganda have adopted. Strict liability, coupled with the strict redress policy, has meant that even in instances when the technology has been approved by the regulatory authority, companies or organizations introducing the technology would be subject to prohibitive level of risk, which has discouraged external and domestic investment.

Tanzania ratified the Cartagena Protocol on Biosafety in 2003, and passed the Environmental Management Act in 2004, which established that the Environmental Ministry will control the regulatory system for evaluating new biotechnology. By placing jurisdiction within the Environmental Ministry, which is much more focused on potential environmental consequences than on potential agricultural benefits, Tanzania reaffirmed its restrictive approach. In many ways, this decision has limited the ability of the science and agriculture communities to influence the debate.

Science and Research Capacity

There currently are no GMO crops in field trials or under cultivation in Tanzania. However, there are several hubs of innovative agricultural research taking place in Tanzania. For example, there is a publicly funded high-quality biotechnology laboratory located at the Mikocheni Agricultural Research Institute in Dar es Salaam, where laboratory trials are underway on improved varieties of staple crops, including cassava that is resistant to cassava brown streak disease and cassava mosaic disease.

It is also one of five countries working on the Water Efficient Maize for Africa (WEMA) project. The scientific community is skilled and active, and the cadres of serious scientists who are engaged in biotechnology research feel constrained by the current regulatory process. Many in the science community claim that the Ministry of Environment, in whose jurisdiction GM technology lies, places a priority on voices of international NGOs, rather than on the indigenous science community. In particular, they feel their research is hampered because of the prohibitive legal risk associated with importing certain germplasm into the country, due to the strict redress and liability clause. As a result, they feel their freedom and ability to conduct a full range of research is limited.

Recently, Tanzania's hesitation around GM technology caused some questions about its WEMA participation. In addition to conventional drought-tolerant varieties, WEMA has a component of research around genetically modified maize. Tanzania agreed to participate in all aspects of WEMA research, but its regulatory structure has prevented it from conducting confined field trials on the genetically modified varieties. After much negotiation with WEMA officials, Tanzania is proceeding without the genetically modified varieties, although it is unclear how the situation will ultimately be resolved.

The activity and leadership around agricultural research and technology in Tanzania continues to grow. For example, Feed the Future currently supports work to develop a new generation of scientists and researchers through an active program at Ngorongoro University, and will develop science projects and activities that directly link to the Feed

the Future priority of providing high quality inputs to smallholder farmers. The science community appears somewhat puzzled at the government's ambivalence toward the technology, and as research moves forward, they will likely apply increasing pressure on the government to change current policies to allow them to conduct research with these technologies.

Communication and Public Opinion

There are many layers in opinions on GM technology in Tanzania. In the face of strong pressure from both sides, the president and vice president have waffled on this issue, publicly expressing enthusiasm for GMOs and later backing away from enacting change in the face of strong domestic opposition. As it stands now, the debate is largely taking place within the government, as opposed to in the public arena. Conflicting views exist between the Ministries of Science and Technology, Agriculture, and Environment.

One effort to educate the larger public and encourage a national debate about GMOs is led by the Tanzania Commission for Science and Technology (COSTECH), a parastatal organization that serves as the main advisory body to the government on all matters concerning science and technology.[22] COSTECH also hosts OFAB, which is encouraging the debate progresses in a manner that ensures that the discourse is led by African scientists, policymakers, and activists, as opposed to being driven by donor priorities and preferences.

The NGO community is also strong and vocal. Many domestic NGOs are supported by European governments and civil society organizations, and some are suspicious of both the Tanzanian government and the international donors and companies that are providing technology and funding. They see the current approach as too ambitious, noting that the government does a poor job delivering the basics. Some NGOs and civil society groups have been vociferously opposed to the use of GM technology in Tanzania—some say it is a multinational plot to take over Tanzania's farming sector; others say it is an environmental hazard; and many say that they just plain do not like it. Many people note that the need for assistance to smallholder farmers in Tanzania is so vast that GM technology should not be the top priority—that major efforts are needed for training farmers around cultivation techniques, seed systems, and extension efforts. An enduring mistrust of private entities and of American efforts to provide science and technology underlies many of the concerns expressed. The goal of companies "making a profit" in agriculture underlies many people's concerns.

Given the lack of field trials and product development, the debate in Tanzania is theoretical, and largely driven by external actors. OFAB, along with increased engagement from Tanzanian scientists and activists, is increasing the relevance of the debate, but it is moving slowly. The debate is currently being pushed forward by external actors who are putting pressure on Tanzania's leadership to either take action or stay the current course. The president has made a strong commitment to bolstering the agriculture sector as an engine for economic growth and has been working closely with USAID and other donors. Without making a change on the current stance toward biotechnology, potential investors for the agriculture sector may be hard to secure. For Tanzania's efforts to be taken seriously, it may be necessary to address a range of policy-

[22] Tanzania Commission for Science and Technology (COSTECH), "About Us," http://www.costech.or.tz/?page_id=1593.

related issues, including the biotechnology regulatory system. In addition, GMO adoption in neighboring Kenya and Uganda may spur a more active public discussion.

Smallholder Farmers

Much like in Kenya, there is a dearth of quality agriculture inputs in Tanzania. One expert noted that Tanzania is currently producing only one-third the amount of seed it needs to adequately feed its population. Because of a lack of reliability in the seed system, farmers save their seed from year to year, and are not able to generate the increased yields and productivity that could be achieved with even basic hybrids. Restrictive regulations that prohibit seed importation in order to encourage local distribution further exacerbate the problems. Despite the improvements in agricultural technologies and the major international initiatives focused on Tanzania, the way of life for smallholder farmers has not changed significantly. More than a third of children under five are affected by stunting and almost 75 percent of preschool-age children suffer from anemia.[23]

As the recipient of $535 million to support the growing agriculture sector in 2011 and $560 million in 2012, Tanzania is poised to promote major growth in the sector.[24] At the time of writing this report, Feed the Future is just completing its initial assessment of project activities, and projects funded by the New Alliance for Food Security and Nutrition are getting underway. Investments are focused on improving access to higher-quality inputs, training on improved agronomic practices, and major infrastructure projects to facilitate increased communication and market access.[25] The results of these investments will not be seen for some years, but the current work is promising. There is some question about the capacity of the government to manage implementation of so many major, new projects simultaneously. The outcome of this round of investments must be closely monitored and evaluated.

Forecast for Adoption

The forecast for adoption of biotechnology by smallholder farmers is unpredictable. There is little strong support for biotechnology, and the president has not consistently promoted it as a priority for the country. However, there are some important factors that could move Tanzania toward the adoption of biotechnology.

There seems to be increasing pressure from major donors on the president to develop a regulatory structure that will create an inviting investment environment for agriculture, including a strong framework for the use of biotechnology. Donors have made major investments in Tanzania with the belief that they will promote the development of the agriculture sector and reduce poverty. If donors are persistent about the importance of a strong regulatory structure to development, the president may agree and promote the idea publicly and within his government.

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[23] Food and Agriculture Organization, "Nutrition country profiles: United Republic of Tanzania," http://www.fao.org/ag/agn/nutrition/tza_en.stm.
[24] Feed the Future, "Countries: Tanzania," http://www.feedthefuture.gov/country/tanzania.
[25] Feed the Future, *Boosting Harvests, Fighting Poverty: Progress Report* (Washington, DC: Feed the Future, October 2012), http://feedthefuture.gov/sites/default/files/resource/files/ftf_progress_ report_2012.pdf.

Regardless of Tanzania's policies, seeds may move through porous borders into the country from Uganda and/or Kenya, which may begin producing biotech seeds in the next couple of years. This would create the conditions for broader public debate, and may also lead to seeds being transported and planted across borders.

Without a major push from an external force (i.e., other countries in the region moving forward cultivating GMOs or a GM product that is ready for market, demanding regulatory changes), it is unlikely that the debate will change significantly. It is also unlikely that demand from farmers will encourage the development of new products; or that there will be a strong, unified national sentiment that the technology is needed, as there is in Uganda.

Uganda

Uganda's burgeoning scientific capacity, research progress, and broader political will provide a source of great enthusiasm for GM advocates on the continent. Since 2007, the country has made tangible progress toward developing local, commercially viable varieties of GM crops. However, as the National Biosafety Bill 2012 makes its way through Parliament and its passage looks likely, the once-cohesive coalition around the technology appears less certain and the opposition campaign continues to grow increasingly sophisticated and focused. These factors, combined with shifting political priorities in the run-up to the 2016 elections, make it unclear to what extent political will can be sustained.

Regulatory System

The ability to build a constituency around GM and make progress on biotechnology research has been relatively straightforward in Uganda. The country has effectively promoted agricultural biotechnology for much of the past decade by explicitly linking it with developing homegrown solutions to food insecurity. The government has justified its support for GM crops by focusing its efforts on common diseases among staple crops and doing direct farmer outreach. Although authority for research around the technology sits in the Ministry of Finance, the government has done a particularly effective job of ensuring that key stakeholders are well-coordinated and, as one government official described it, "reading from the same script."

Uganda's history working on agricultural biotechnology is quite extensive. The country first established its National Biosafety Committee (NBC) in 1996 and in 1998 began drafting national biosafety regulations. Shortly after signing the Cartagena Protocol in 2000, the NBC reviewed its first GM application. By 2003, the Kawanda Agricultural Research Institute was expanded to a biotechnology research center to accommodate a growing interest in modern biotechnology. By the mid-2000s, transgenic research on bananas had begun, with confined field trials beginning in 2007. These initial experiments drove the need for a regulatory system and capacity-building for GM research.

In 2008, the Ugandan cabinet approved a National Biotechnology and Biosafety Policy to guide the development and application of GMOs and other modern biotechnology. Essentially, the law sought to create legal boundaries for the research already underway. After eight years of drafting comprehensive legislation, in January 2013, the National

Biotechnology and Biosafety Bill 2012 was introduced in Parliament and is currently under public debate. The bill is widely viewed to be serious and fair, and there is a high level of confidence that it will move forward, though it has proven more controversial than initially anticipated. Uganda's Attorney General's office, which drafted the legislation, consulted similar laws throughout the continent and borrowed clauses that could be applied to the Ugandan context. It also took potential parliamentary champions to other countries to build support for the legislation, what one government official coined the "seeing is believing tour." According to an expert on biosafety legislation, the legislation's biggest strength is that it builds on existing law and does not tackle those issues for which there is already precedent, including liability and redress. The bill provides the legal framework for researching and testing GM varieties, and sets out the approach for open field trials and eventual commercial release.

Science and Research Capacity

According to a U.S. government official in Kampala, "Ugandan scientists are getting better as a community. While Kenyans have been ahead in terms of the law, Ugandans are ahead in advancing the science itself." Uganda has several active confined field trials of GM crops underway, including 16 promising lines of banana to resist ring worm and bacterial wilt. Uganda's National Agricultural Research Organization (NARO) is the most active in the country's biotechnology research efforts. It coordinates, guides, and oversees all agricultural research to ensure quality control. Of the 13 applications for GM research approved by the NBC, 10 are being conducted by NARO scientists at the Kawanda Agricultural Research Institute. In fact, no field testing is allowed without NARO partnership, so any part of the limited private research infrastructure in Uganda will still require public support to test new varieties.

The scientific community in Uganda is largely trained at Makerere University, with additional education in South Africa, Europe, and the United States. There is a frequent flow of communication and exchange between researchers and their peers at the university and in the ministry. Comparatively speaking, government funding for research is fairly robust and has quadrupled between 1995 and 2008. NARO accounts for the vast majority of research spending, as much as 73 percent in 2008.[26]

Currently, phased commercial release is anticipated over the next several years of the following crops: an international variety of cotton (2015); a local variety of biofortified vitamin A banana (2021); a local variety of virus-resistant cassava (2018); and a regional variety of insect-resistant (2015) and drought-tolerant maize (2017). The country is also beginning to explore second-generation GM varieties, including rice, tomatoes, sorghum, wheat, peanuts, potatoes, and nutrient-enriched cassava.[27]

Still, Uganda's research and infrastructure have their limitations and are still developing. Experiments have yielded both positive and negative results. As one scientist described it, "failure has been a big teacher." The first GM experiments on banana, for black sigatoka disease, received significant media attention. When they failed, scientists shifted their strategies based on the lessons learned and as a result are now getting ready to

[26] Kathleen Flaherty, Dan Kitone, and Nienke Beintema, "Uganda: Recent Developments in Agricultural Research," Country Note, Agricultural Science & Technology Indicators (ASTI), July 2010, http://www.asti.cgiar.org/pdf/Uganda-Note.pdf.
[27] Andrew Kiggundu, e-mail to author, October 7, 2013.

develop black sigatoka-resistant bananas using a different technology. Additionally, there has been a premium placed on managing expectations by the scientific community. While President Museveni has publicly stated to farmers that his scientists are working on the common pests that afflict their crop, scientists have been less willing to engage the end user. While this poses a challenge for demand creation, one scientist simply explained that this is not yet an issue because the products intended to first go to market are "not quite there."

Communication and Public Opinion

In Uganda, science communication has been a priority. Along with research and regulation, there has been a concerted effort to connect the scientific community with journalists. An association of science journalists has been formed to encourage high-quality reporting on all aspects of science; and an active dialogue among scientists, policymakers, journalists, and activists has provided an opportunity to discuss and clarify key questions and issues around biotechnology. As a result of the consistent national discussion about the potential roles of GMOs in combating food security, bolstered by regular media coverage, nearly everyone interviewed had a similar understanding of the issues, and a common approach on the importance of the technology to Ugandan farmers.

Smallholder Farmers

Despite promotion and education about biotechnology among government, the scientific community, and upper echelons of society, GMOs are relatively unknown among most smallholder farmers in Uganda—those whom the technology is intended to help the most. Hybrid adoption is limited, and there is little trust in the formal seed system. Use of improved seeds is estimated as low as 10 percent.[28] Saving seeds is still the dominant practice. Many farmers have heard the term GMO on the radio or in conjunction with negative effects. But few farmers have a firm understanding of what GM seeds are or why they would be used.

Despite the government's commitment and the cohesiveness of the message about the importance of GM technology for Uganda's food security, this information is clearly not reaching many smallholder farmers. CSIS researchers spent the day with a group of smallholder farmers working with HarvestPlus in Uganda growing conventionally bred orange-fleshed sweet potatoes. One of the most striking takeaways was the intense effort by HarvestPlus on behavior change—encouraging farmers to switch from their traditional white-fleshed sweet potato to the vitamin A-rich orange version. This experience clarified some of the real challenges of adoption of GMOs by smallholders. In order for farmers to even demand GMOs, they need to be engaged by the government and scientists with good information, and be able to witness firsthand the various crops and decide what is best for their individual farms.

Should these crops be commercialized and demanded by farmers, the next hurdle will be to adequately ramp up production and distribution of seeds and planting materials, and to conduct training on appropriate techniques for planting and crop management.

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[28] Ruth N. Ssebuliba, *Baseline Survey of the Seed Sector in Uganda, In Relation to Regional Harmonization of Seed Legislation* (Kampala: African Seed Trade Association, September 2010), http://afsta.org/wp-content/uploads/documents/UGANDA%20SEED%20SECTOR% 20BASELINE%20STUDY.pdf.

Private companies do little research of their own; all varieties must be created in the National Agricultural Research Organization (NARO), and companies license the right to commercialize the varieties. Although Uganda has made the most progress in terms of research and development of products, the control that the government exerts over the process creates a lack of connection to the customer and a shortage of marketing expertise. Poor internal regulation and lack of competition means that widely available counterfeit seed is also a major problem. Farmers who buy seed may not receive what they expect (in some cases, it is regular maize from the market, just painted to look like hybrid seed corn) leading to weak results, disappointment, and mistrust in the seed system. Without a focused effort—and a strong partnership between the government and the companies—on ensuring quality, quantity, and authenticity of the new varieties, farmers may be unwilling to invest in the new seeds, even if they do hold the promise higher yields and disease resistance.

Gaps in extension are also a serious challenge. As products are scheduled to move into market over the next few years, this will be the formidable challenge. The government has made a major effort to improve Uganda's extension system, the National Agricultural Advisory Services (NAADS), but still is unable to effectively reach the large number of farmers needing advice and information. Some NGOs have taken the role of working with farmers to improve productivity and systems. Many are doing good work, but the variety of approaches can lead to confusion. Some groups are more focused on agroeconomic approaches and others are focused on new technologies; both approaches can be effective, but the diversity of messages has led to uneven information and practices. All farmers and field workers would benefit from a more unified set of information and messages from the government to ensure that accurate information is consistently shared on a range of issues, including planting practices, emerging disease and pest threats, and how to manage weather challenges.

Forecast for Adoption

While forward movement on GM is likely in Uganda, it will not be an entirely smooth process. As the 2016 elections near, more pressing political matters will likely capture the attention of higher-level government officials. While constituencies against the legislation are not particularly strong, there are no exceptionally robust champions either. And, with high turnover among MPs, individuals who were once strong advocates regularly leave Parliament, forcing supporters to start rebuilding a coalition from the ground up. Because the Uganda National Council for Science and Technology (UNCST) falls under the Ministry of Finance, that has been largely supportive to this point, GM issues are less of a priority for them and they are often overtaken by more direct ministry interests.

Although the opposition movement is smaller compared to those in Kenya and Tanzania, it is growing as crops and legislation move closer to reality. Groups that oppose the technology are beginning to mobilize more aggressively now that the bill is underway. The opposition movement—led by primarily the National Organic Agricultural Movement of Uganda (NOGAMU) and the Participatory Ecological Land Use Management (PELUM)—is gaining some parliamentary support. The resistance movement is largely focused around the fear of contamination of local varieties and subsequent effects on market access. While they seemed unlikely to have much of an effect on the debate when

the legislation was first introduced, their influence has grown and the debate around the legislation is becoming more contentious than anticipated.

Many believe that legislation will likely pass, and if it does so soon, scientists estimate the improved bananas could be released as early as 2018.[29] Still, important questions remain. Many agree that the legislation was thoughtfully crafted, but little consideration has been devoted toward an implementation plan. Socioeconomic factors, including cost and access by smallholder farmers, are also major concerns that have not yet been addressed. Regardless, these issues are likely outside of the purview of a biosafety law.

[29] Andrew Kiggundu, e-mail to author, October 7, 2013.

3 | Regional Dynamics and Trade Implications

Agriculture is one of the sectors of greatest importance to East Africa. But, there is a palpable sense of fear that commercialization of GMO food crops in the region could negatively impact their export markets, especially those in Europe. Many African countries have strong historical trading ties with European countries, where the public is by and large opposed to consuming GMOs. Interestingly, the European Union imports more than 70 percent of its commodities like corn and soya to supply its feed industry from the United States, Brazil, and Argentina, of which almost all is GM.[30] At the same time, forgoing the production of GMO crops could have food-security impacts at both the domestic and regional levels by keeping important tools out of the hands of farmers. Concerns about negative trade implications have some legitimacy, but when examining the trade data of GM varieties of maize, cotton, and cassava, there is little evidence that the commercialization of GM crops currently under development in the East African Community (EAC) would pose significant trade losses.

Most significantly, the majority of these crops are traded intraregionally, not internationally. For example, the export of maize from the EAC countries to the rest of the region and other African countries accounts for 98.6 percent of total maize and maize product exports. Following a similar trend, exports of cassava and cassava product to the continent account for 96 percent of the total cassava export value.[31] Furthermore, the agricultural commodities most exported from Africa to Europe (coffee, tea, sugar, and cocoa) are not GM crops, and are not grown as GM crops anywhere else in the world.[32] Finally, GM varieties of maize and cotton are generally accepted in other importing regions of the world, which have increasing food demands. Should Europe turn these products away, there are alternative markets to which African countries could export these crops.[33]

Although potential losses in trade may be limited, given existing trade data of crops for which a GM alternative is being developed, there are still real fears that should not be simply dismissed. Given the rise of retailers and grocers that are developing "GM-free" standards, producers may be reluctant to purchase ingredients for processed goods from countries that also produce GM varieties for fear they will not be able to assure the GM-free standard when exporting to countries that do not allow GM food products. The influence of these retailers may indirectly influence African policymakers as they set their own policies towards GMOs.

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[30] Food Standards Agency, "GM Material in Animal Feed," July 3, 2013, http://www.food.gov.uk/policy-advice/gm/gmanimal#.UkWsN4ZeZ8F.
[31] Komen and Wafula, *Trade and Tribulations*, 18.
[32] Ibid., 13.
[33] For more information, see Stuart J. Smyth, William A. Kerr, and Peter W.B. Phillips, "Accelerating adoption of genetically modified crops in Africa through a trade liability regime," *Plant Biotechnology Journal* 11, no. 5 (June 2013): 527–34, http://www.ncbi.nlm.nih.gov/ pubmed/23601418.

The Regional Economic Communities (RECs) in Africa have highlighted the need for economic integration to facilitate trade and investment, and reduce trade-distorting policy barriers. Given the trade data, the most meaningful and advanced commercial trade for the focus countries occurs at the EAC level. To ensure food security of the region, intraregional barriers play the largest role, especially for those foods most traded and consumed at the local level—maize, cassava, and bananas. Both the EAC and the Common Market for Eastern and Southern Africa (COMESA) have efforts underway aimed at harmonizing biosafety policies to address potential trade barriers in key agricultural commodities. The EAC's Protocol on Environment and Natural Resources Management says that partner countries should develop and adopt common policies that will "harness the potential benefits of modern technology and prevent harmful effects of technology," but thus far not much progress has been made in actually putting this policy into action.[34]

COMESA is also working to develop strategies to harmonize biotechnology and biosafety policies through the Regional Approach to Biotechnology and Biosafety Policy in Eastern and Southern Africa (RABESA), which was developed by COMESA agriculture ministers in 2001. Due to the increased level of interest in pursuing biotechnology throughout many COMESA countries, a coordinated regulatory approach will be important to facilitate regulation and trade flows in the region. Given that agriculture composes more than 32 percent of the GDP in COMESA and provides 65 percent of industry's raw material, this could have an important economic impact. However, the 19 COMESA member states are in very different states and intentions in developing their national biosafety frameworks. While efforts continue at the COMESA level to adopt proposed policy on GMOs, there is still disagreement about a harmonized approach and skeptics point out that seed harmonization plans have not borne fruit in the past, in spite of years of effort.[35]

Ultimately, it is unlikely that harmonization efforts will move forward absent a commercially available product on the market. If or when one of the East African countries moves forward with GM cultivation, the neighboring countries will need to address it in short order. If farmers demand these products, national borders are unlikely to contain them.

[34] Komen and Wafula, *Trade and Tribulations*, 19.
[35] For additional information on COMESA biotechnology harmonization efforts, see Margaret Karembu, David Wafula, and Michael Waithaka, "Status of Biotechnology Policies and Biosafety Legislation in the COMESA Region," Program for Biosafety Systems, September 2009, http://pbs.ifpri.info/2009/09/14/status-of-biotechnology-policies-and-biosafety-legislation-in-the-comesa-region/.

4 | Recommendations

It is clear that technology has an important role to play in improving food security of smallholder farmers and the overall development of each country. However, in order for farmers to reap the benefits of any technology, major investments are needed in basic agricultural systems. Farmers need better access to quality seeds, fertilizer, education, credit, and storage. The potentials of GM—or any other existing technology—will provide benefits in scale with the improvement of systems to deliver basic agricultural inputs and education. As the debate on GM adoption evolves in each of the focus countries, there are some important considerations.

Develop Desirable Products

- Local and donor governments must support scientists and research; focus research on products and crop varieties that are locally adapted and will be accepted by farmers—who are in most cases also the consumers.

- Researchers should be pushed to test and move out varieties in a timely manner. Without varieties visible and available, the debate is abstract, confusing, and often negative. Decisions about planting and using biotech crops should be based on experience with real crops; if there are none, attention and interest will wane.

- EAC countries should collaborate on specific research projects in order to overcome challenges arising from lack of appropriate facilities, capacity, and/or funding. This will enable research to advance more quickly.

Focus on Technology Transfer

- Governments and donors must focus on getting technology and knowledge into the hands of farmers. The process of moving from the lab to the field is a difficult one in any case; but it is more difficult in these three countries because the varieties will be owned by the government, reducing the incentive to push them rapidly and robustly to farmers.

- Seed systems require much greater focus. Exchanges for seed breeders and distributors could be helpful approaches to encourage enthusiasm and skill.

- Extension and agricultural education need major refreshment. While government extension agents are important, and their opinions matter, there are not enough to reach and teach all smallholder farmers. Distributing biotechnology seeds (or any seeds) will require training and teaching for farmers; new approaches can include farmer classes and seminars, NGOs reaching their communities, and train-the-trainer and fee-for-service models.

- Financing will be required. Even though the technology will be owned by the government, farmers will need loans to purchase seeds. Models of loans plus

technical training and follow-up, of which trainer salaries can be paid by the loans, could prove successful.

- African governments and universities should maximize synergies to sustain investment and knowledge in applied agricultural research.

Deepen and Cement Regulatory Structures

- The U.S. government, in particular USAID, has effectively and respectfully supported the groundwork for regulatory systems in countries that wish to pursue a biotechnology policy. This work has been targeted and respectful of the countries' wishes and development goals, implemented through the Program for Biosafety Systems, and should be continued.

- For the purpose of the focus countries of this study, and given their relative economic importance to each other, focused efforts at the EAC should continue. This could also lay useful groundwork for future COMESA harmonization.

Communicate Benefits

- Biotechnology should be considered and presented as a tool to fight poverty and improve food security. The debate over GMOs should be used to create a national dialogue on innovative ways to tackle food insecurity and engage the broader public. Coordinating messages around the core food security goals of the country and explicitly link GMOs to specific challenges it could potentially address, like chronic, cyclical drought, pests, and crippling crop diseases, in addition to low productivity, could prove useful.

- Train, recognize, and reward agricultural communicators. Agriculture and science journalists desire training and recognition for their work. Awards for outstanding journalism help promote strong and neutral reporting.

- Consider strengthening the role and capacity of the Open Forum on Agricultural Biotechnology (OFAB) in East Africa to reach a broader audience of consumers and farmers. Resources have already been devoted to developing this body; further extending its outreach capabilities could improve public awareness and access to information.

- For those countries that wish to pursue GM, the United States—specifically NGOs, foundations, and journalist organizations—could help in training journalists and others who might help communicate the science in a neutral, informative manner.

- Governments and the science community should address the perceptions about concerns regarding European markets by sharing information and data showing that GM crops grown in these countries are most likely to be consumed locally. Concerns that cultivating GM crops currently under developments will cause a loss trade with Europe have largely been disproven, yet there is still a very real fear among farmers and producers that their products will be locked out of the market.

5 | Conclusions

The food security situation in the three focus countries—Kenya, Tanzania, and Uganda—is tenuous and is likely to only become more challenging in the face of growing populations, erratic weather patterns, and the rise in crop diseases and pests. Given that the large majority of the countries' populations are engaged in farming, agriculture is also an essential component to economic development and poverty alleviation.

Donor countries, as part of their broader food security and development aid, can support countries' efforts to pursue GM technology by providing scientific and technical assistance to scientists and regulators, and training journalists to communicate information in a neutral, informative way. More broadly, donors should focus on improving agricultural productivity, investing in research, and encouraging technology transfer, which will accomplish both achieving quick wins in the short term while making the investments that are needed for long-term agricultural development.

Ultimately, the success of GM products will be defined by each country's ability to get locally relevant products on the market, accompanied by consumer and farmer demand. This will be a long, hard, and incremental effort that will require sustained political will behind it. Furthermore, progress is likely to be vulnerable to stalls and regressions as anti-GMO activists become reengaged at each stage. Once a successful product is on the market, this situation will likely change as farmers have the option to choose which products they prefer to grow and consumers have various product and price options. At the regional level, these three countries are closely tied and are following how the debate is unfolding in each other's nation. It is likely that once one of these countries moves toward commercial production, it will be difficult to contain within national borders.

As countries move forward in their domestic debates on GMOs, it is essential to keep in mind that the end goal should be to improve the food security of their populations. This will likely happen in different ways, but regardless, governments and scientists should work to create and release products which will be demanded by farmers and address their biggest challenges. In order for any of these technologies to realize their potentials, a sustained, focused investment in developing the broader agricultural system is essential.

| Appendix: Methodology

Kenya, Tanzania, and Uganda were selected because each is at a different point in their domestic debate and development of biosafety regulatory systems. They provide an interesting and useful comparison in examining how the debate is evolving in each of the three countries and potential areas of harmonization and/or cooperation. Additionally, they were chosen due to their geographic proximity and membership in common regional organizations of the East African Community (EAC) and the Common Market for Eastern and Southern Africa (COMESA).

The research for this report is based on field studies in each of the three countries between August 2012 and February 2013. Interviews were conducted with government officials in relevant agencies, policymakers, scientists, the private sector, smallholder farmers, nongovernmental organizations (NGOs), media, and other interest groups. The team of three researches spent one week in each country, conducting close to 100 meetings and interviews. Additionally, the research team conducted interviews and small roundtable discussions in Washington, D.C., with a variety of experts in these fields. The primary research has been bolstered by desk research, and the development of an online blog forum to gather broader opinions and share experiences.

CSIS published two additional technical papers to supplement the findings of this report. *Trade and Tribulation: An Evaluation of Trade Barriers to the Adoption of Genetically Modified Crops in the East African Community* by Dr. John Komen and Dr. David Wafula (May 15, 2013) evaluates the potential trade implications of the adoption of GM crops, within the EAC, within Africa, and with their international trade partners. *Biosafety of GM Crops in Kenya, Uganda, and Tanzania: An Evolving Landscape of Regulatory Progress and Retreat* by Dr. Judith Chambers (forthcoming) provides an in-depth analysis of the biosafety regulatory systems of each of the three countries. These publications and additional information can be found at https://csis.org/node/21135/publication.

To supplement the field and desk research, CSIS launched an online forum "Pathways to Productivity," hosted at http://food.csis.org. This blog publishes analysis, commentary, and fact-based posts related to the role agricultural technologies—including biotechnology and genetic modification—might play in food security. We continue to post articles from the U.S. and international policymaking community, food security experts, agricultural scientists, the media, academia, the NGO community, and farmers.

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Kristin Wedding is deputy director and fellow with the CSIS Global Food Security Project, where she works on policy issues related to enhancing global food security, reducing global hunger, and fostering U.S. agricultural development efforts. Most recently, she was codirector on a project examining the debate on genetically modified (GM) food crops to improve food security in Kenya, Tanzania, and Uganda. Ms. Wedding has authored several reports on food security, including *Strategic Partnerships to Build African Scientific Capacity for Agriculture* (CSIS, December 2011) and *The Role of Markets and Trade in Food Security* (CSIS, June 2010), *Cultivating Global Food Security: A Strategy for U.S. Leadership on Productivity, Agricultural Research, and Trade* (CSIS, April 2010). She also served for five years as assistant director for corporate relations in the CSIS Office of Strategic Planning, where she was responsible for managing the Center's relationships with companies in the defense and technology sectors. After joining CSIS in 2005, she worked 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. Ms. Wedding has nine years of experience in the foreign policy sector. She holds an M.A. in international political economy from the American University School of International Service, and she earned a B.A. in international relations and Spanish from Florida State University.

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