

ADVANCING GLOBAL FOOD SECURITY

THE POWER OF SCIENCE, TRADE, AND BUSINESS

Cochairs

Catherine Bertini and Dan Glickman

Advancing Global Food Security: The Power of Science, Trade, and Business

The Chicago Council on Global Affairs



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Report issued by an Independent Advisory Group
on Global Agricultural Development

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Catherine Bertini and Dan Glickman

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Advisory Group

Cochairs

Catherine Bertini, Former Executive Director, World Food Program, United Nations

Dan Glickman, Former Secretary, US Department of Agriculture

Members

Doug Bereuter, President Emeritus, The Asia Foundation; Former Member, US House of Representatives

John Carlin, Visiting Professor and Executive-in-Residence, Kansas State University; Former Governor, Kansas

Wendy J. Chamberlin, President, Middle East Institute

Jason Clay, Senior Vice President, Markets, World Wildlife Fund

Gordon Conway, Professor of International Development, Imperial College London

Gebisa Ejeta, Distinguished Professor of Plant Breeding and Genetics, Purdue University

Mark E. Keenum, President, Mississippi State University

Jo Luck, Former President and CEO, Heifer International

Earl Pomeroy, Former Member, US House of Representatives

Beth Sauerhaft, Director of Global Environmental Sustainability, PepsiCo

Paul E. Schickler, President, DuPont Pioneer

Ritu Sharma, President and Cofounder, Women Thrive Worldwide

Robert L. Thompson, Visiting Scholar, John Hopkins University's School of Advanced International Studies; Professor Emeritus, University of Illinois

Ann M. Veneman, Former Executive Director, United Nations Children's Fund; Former Secretary, US Department of Agriculture

Joachim von Braun, Director, Center for Development Research, University of Bonn

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Foreword

In the 21st century the world faces the multiple challenges of feeding growing populations, alleviating poverty, protecting the environment, and responding to climate change. Left unchecked, these challenges will perpetuate hunger and malnutrition, slow economic growth, spur political instability, and threaten irreversible damage to the environment and human survival. Since 2009 the US government has taken steps to confront these challenges through agricultural development. For the first time since the Green Revolution, empowering the world's poorest to improve their livelihoods through agriculture is at the top of the international agenda. If these efforts are supported and expanded, it will be possible to reduce poverty and meet future food demand sustainably.

For progress to continue, government, business, and civil society must continue to work together to chart a course to meet future food needs in a way that improves nutrition, supports economic development, increases resilience to extreme weather variability, and preserves the environment. The next phase of US leadership needs to recognize both the complex interactions of agriculture with health, resource limitations, and climate change and the importance of trade and business in fostering food security. Farmers and businesses in the United States and abroad need access to advanced innovations in order to produce more nutritious food with fewer resources and less environmental impact. Trade in agriculture and food commodities needs to flow more freely between areas of surplus and deficit. And governments must focus on the policies and investments that will make it possible for companies to thrive in new markets and develop and broadly disseminate innovations to increase nutritious food production.

The Chicago Council on Global Affairs launched a project in mid-2008 to provide new thinking on how the US government could renew its leadership on global agricultural development to alleviate poverty, advance global food security, and spur economic growth and social stability. The project's landmark report, *Renewing American Leadership in the Fight Against Global Hunger and Poverty*, was issued in early 2009 by a bipartisan group of interested Americans. It called on the United States to reinvigorate investment in agricultural systems in the developing world, with a focus on smallholder farmers, especially the women who farm most of the world's small holdings. The report put forward specific recommendations for US action that, if implemented and sustained, would lift millions of people in Sub-Saharan Africa and South Asia from poverty.

The recommendations of the 2009 Chicago Council report—to reenergize support for agricultural research, extension, education, and rural infrastructure and to reform development delivery mechanisms—are still highly salient. But emerging global issues necessitate a refresh of US priorities and strategies for achieving global food security and raising the incomes of smallholder farmers and rural populations, the majority of the world's poor. The current administration and 113th Congress require the most up-to-date analyses and recommended options for action if the United States is to continue to champion and lead the cause of global agricultural development.

Beginning in May 2012, The Chicago Council's Global Agricultural Development Advisory Group examined anew the opportunities for the United States to advance food security, health, environment, and economic growth goals through agricultural development. Cochaired by Catherine Bertini, former executive director of the UN World Food Program, and Dan Glickman, former US secretary of agriculture, the bipartisan

Advisory Group brought together 15 distinguished individuals with expertise in food and agriculture, foreign policy, development, US public policy, business, and international organizations. This report lays out the Advisory Group's findings and recommendations as well as the arguments for taking immediate action to implement them.

Acknowledgments

The Chicago Council would first like to thank the Advisory Group cochairs, Catherine Bertini and Dan Glickman, for their skillful and dedicated leadership throughout this study's demanding 12-month process. The issues surrounding agricultural development are complex and require expertise from individuals from a wide array of disciplines and backgrounds. It speaks to the stature, insight, and energy of Ms. Bertini and Mr. Glickman that the study was able to assemble a diverse group of wide-ranging expertise and incorporate these perspectives into a thorough, well-founded report.

The Council extends its deepest appreciation to the members of the Advisory Group. Each had distinct experiences and views on the issues considered, yet worked together effectively to achieve consensus on the report's recommendations. I would like to especially thank them for their time and willingness to offer their expertise and exchange views candidly during and following the group's deliberations.

The Council is very grateful to Connie Veillette, who served as the senior consultant and principal writer of this report. Dr. Veillette, who is one of the most respected US policy experts on agricultural development and food security issues, brought her great wealth of knowledge and insight to the framing of this study's agenda, skillfully led the research process, and spearheaded the writing of the findings and recommendations.

The Council would also like to thank David Joslyn and Scott Kilman for their invaluable contributions to the creation of this report. David Joslyn, senior advisor to the Global Agricultural Development Initiative, worked closely with Dr. Veillette in scoping the study, carried out interviews with experts during the research process, and provided guidance and inputs throughout the report drafting. Scott Kilman drafted the final report. Drawing on his own expertise accrued from decades of reporting for *The Wall Street Journal*, Mr. Kilman brought his talents as writer, expert, and diplomat to the report.

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Lisa Eakman, executive director of the Council's Global Agriculture and Food portfolio, directed the study. Cortney Ahern, project and research assistant, expertly oversaw the day-to-day management of all aspects and participants in the report's development. Research assistants Justin Lawrence and Julie Santella played key roles in the research and report drafting processes with unmatched dedication and accuracy. Interns Grace Tamble and Jenny Chung assisted with collecting report photos, references, and other appendices. Senior editor and research analyst Sung Lee contributed valuable research support, senior fellow Roger Thurow shared his stories of smallholder farmers from the field, and assistant director Maggie Klousia played a key management role in the initial stages of the study. Catherine Hug and Duane Nelsen of Chicago Creative Group edited and designed the report.

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Marshall M. Bouton
President
The Chicago Council on Global Affairs

EXECUTIVE SUMMARY



Part I—Challenge and Opportunity: Advancing Global Food Security through Agricultural Development

The world is facing perhaps the greatest challenge of a generation: how to feed two billion more people nutritiously in the decades ahead. This—combined with rising incomes in the developing world and growing needs for energy—is increasing demand for agricultural products at an unprecedented rate. With global demand for food expected to rise 60 percent by 2050,¹ the world's farmers will need to produce as much food over the next 40 years as they have in thousands of years to date.

Globally, nearly 870 million people are already chronically hungry.² In 2013 the world will likely consume more grain than it produces.³ With the buffer against shortages shrinking, food prices have sharply increased in recent years around the world, slowing progress in reducing the proportion of hungry people. At the same time, global agricultural production is not increasing at the same rate as it has in decades past. Water and untapped productive land are getting harder and harder to find. Climate change is projected to make food production more unstable by upending the places where crops can be grown and by stirring up agricultural diseases and pests.

Left unchecked, these problems will only worsen. Not only will millions more people be sentenced to lives of hunger and malnutrition, but societies will become increasingly unstable. Hunger and conflict are bound together. Insufficient food production or barriers in agriculture and food trade result in food shortages, making people angry and desperate enough to take to the streets or take up arms. Riots in dozens of countries around the world in recent years have been linked to commodity price spikes. When events spiral out of control, US intervention in the form of emergency food assistance—or even more costly military engagement—becomes more likely.

Yet this course of events is not inevitable. History has proven that agricultural development is one of the most effective ways to remedy food security-related challenges. In particular, global food security is advanced when the world empowers smallholder farmers in Sub-Saharan Africa and South Asia to maximize their agricultural potential. These regions are agriculture's last untapped frontiers. Their farmers' isolation from methods that increase their production of nutritious foods and therefore increase agricultural incomes not only condemns hundreds of millions of people to chronic hunger, it denies global markets a tremendous source of food.

Done properly, agricultural development increases production, improves nutrition, protects the environment, and raises incomes among some of the world's hungriest people. It drives economic development and reduces poverty while creating new markets and social stability. New research suggests that helping smallholder farmers in poor nations become self-sufficient is also one of the most effective types of foreign aid for promoting peace.⁴

Global food security is a challenge for America

As the world's leading agricultural power, the United States has an immense opportunity to lead the international community in addressing the challenge of global food

security through agricultural development. While the United States has taken positive steps over the past several years to move in this direction, much more must be done in the coming decades to meet the complex challenges of feeding the world. Now is the time to move the agenda forward.

The United States possesses the most successful agricultural research enterprise globally through its universities, research institutes, and agrifood businesses. It has the capacity to rally the necessary resources and expertise at home and abroad toward equipping the global agriculture and food system to sustainably meet future demand. Through the right partnerships with other governments and organizations in both the developed and developing world, smallholder farmers living in Sub-Saharan Africa and South Asia can get the tools needed to lift themselves and others from poverty and become part of the solution.⁵ By leading this charge, the United States would also create more American jobs, expand trade and investment opportunities, grow markets, and increase US influence globally, including in regions that will become increasingly important strategically in the years ahead.

US leadership in agriculture was built on a strong foundation of public investment in science that began when the nation was young. These investments capitalized on the ingenuity of business to both fund innovation and help bring it to market. The complementary roles of the public and private sectors in agriculture have yielded impressive results. The US farm sector was able to produce five times as many crop and livestock products in 2007 as it did in 1910 on less and less inputs.⁶ US farmers grow enough to supply domestic markets and, in years with good weather, export roughly half of their wheat and rice and more than 40 percent of their soybeans.⁷

The problem is that US farmers' success has bred complacency in America about the challenges of feeding the world. Federal spending on agricultural research has been largely stagnant for three decades and even slipped in recent years when the figures are adjusted for inflation.⁸ China, meanwhile, has leapt past the United States as the biggest funder of public agricultural research.⁹ While the private sector has been expanding its spending on research and development of agriculture and food, private-sector spending alone is not enough to get US farm productivity growing at the necessary rate, let alone address the complex challenges in developing countries.

The world needs a new US agenda for global food security focused on science, trade, and business

If future generations are to be fed, innovation in the agriculture and food sector must be dramatically ramped up. Based on US experience, this can best be achieved by focusing on three key areas: science, trade, and business. These are areas in which the United States has a comparative advantage and the capacity to lead.

The United States can exert this leadership by embracing a strategy that mobilizes and equips the scientific community to develop and deploy innovations all along the food chain, that increases trade to improve market access and flow of agricultural and food goods globally, and that capitalizes on the power and reach of the private sector to advance global food and nutrition security.

Public agricultural and food science must be energized

Science has made it possible to increase agricultural production exponentially in the past century. Yet the science of the past will not meet the demands of the future. The challenge of increasing agricultural production to meet current and future demand is now infinitely more complex. Food production will need to take into account environmental impact, producing more using less land and water resources and adapting to climate change and greater weather variability. It also needs to balance nutrition and energy needs.

To equip the agriculture and food system to meet these challenges, this report calls on Washington to make agricultural innovation a priority on its international and domestic agenda. It asks Congress and the White House to give America's public research system a new mission: reinvent US and global agriculture so that it is far more productive, environmentally sustainable, nutritious, and resilient to setbacks through a focus on *sustainable intensification*.

Sustainable intensification equips farmers with the innovations to:

- increase production of nutritious foods, bringing higher incomes to small-holder farmers,
- conserve land and water with efficient and prudent use of inputs,
- improve human health through accessible food that is nutritious,
- adapt to climate change,
- reduce environmental impact,
- reduce food waste along the supply chain.¹⁰

The mission of sustainable intensification should draw on expertise from a broader array of scientific disciplines and be carried out by researchers and institutions—both public and private—in the United States, at international research centers, and at research institutes and universities in developing countries. Sustainable intensification must also include a focus on a broader set of crops to feed humanity. Corn, wheat, and rice now supply most of humanity's calories. Yet it is becoming risky to have humanity depend so heavily on so few crops. The range of crop varieties grown around the world today is so narrow that a single plant disease can cause a food crisis. The tools and technologies to carry out sustainable intensification will be different depending on the location, but the principles are the same.

The current way the United States carries out agriculture and food science makes it difficult, if not impossible, to meet the goals of sustainable intensification for two reasons. First, there are limited incentives for scientists in other disciplines to collaborate to meet agricultural challenges. Second, there is ineffective transmission of innovations to farmers in low-income countries who are often the least productive.

The US government should provide agricultural and food science the incentives, including the resources, it needs to fully deploy current tools such as conventional breeding, hydrology, and conservation tillage as well as take full advantage of an exploding array of new tools such as bioinformatics, geographic information systems, tailored precision agriculture, molecular breeding, irrigation technologies, and biofortification. This will include more funding for basic research as well as competitive grants,

which have proven valuable in spurring innovation. The US government should also ramp up research to produce and disseminate these innovations to farmers everywhere, especially women smallholder farmers, who have been largely neglected even though they do roughly half the farming in Sub-Saharan Africa.¹¹

Trade and business must be invigorated

Science cannot create global food security on its own. Any drive to rejuvenate agricultural and food research is wasted unless innovations are distributed and can be applied by farmers everywhere and unless the resulting output makes its way to agricultural markets. Trade and business play critical roles in these areas. Many countries' food security depends on trade, yet only 25 percent of food crosses borders.¹² The United States should work harder to make expanded trade and the unfettered movement of food and agricultural commodities a higher priority on its international agenda. This includes trade among developed countries, between developed and developing countries, and among developing countries.

The US government must also encourage private-sector involvement in the developing world by helping create an enabling environment for enterprise. Helping countries harmonize regulatory systems, make infrastructure investments, and lay the policy foundation for business development would smooth the way for private-sector participation.

Global food security is in America's interests

The United States has before it the opportunity to be a catalyst to advance global food security. The blueprint put forward in this report calls for the US government to lead an international effort to mobilize science, increase trade, and leverage the strengths of business to advance global agricultural development as a means to increase food security. The United States has proven it can provide international leadership in the quest toward global food security and encourage others to act on this issue. It has the expertise, institutions, and experience to energize this effort. What is required is the vision and commitment of American governmental, university, research, and business leaders working alongside their international counterparts.

The recommendations in this report, if implemented and sustained, will help lift hundreds of millions of people out of poverty over the next two decades and help ensure sustainable food and nutrition security for future generations to come. They will also guard the world's natural resource base, make agriculture more resilient to climate change, and contribute to economic growth and social stability in regions of the world that are key to US interests.

If the United States fails to form a strategy, or if attempts to meet future food demand would falter, progress toward reducing global poverty may halt, and America's domestic and international interests may be put at risk. Hunger would sow more conflict and political unrest in parts of the world that are vitally important to US interests. The number of those living in chronic hunger would increase. The United States could miss the opportunity to cultivate new markets in developing countries. The American farm belt—one of the strongest parts of the economy—could lose export opportunities and see its future prospects dim.

The United States helps itself by helping spur agricultural development in poor regions of the world. Nine of the ten economies projected to grow the most in the next five years are in South Asia and Sub-Saharan Africa.¹³ Agriculture is either the largest sector or the activity on which the most people depend for their livelihoods in many of these economies. As growth in agriculture reduces hunger and poverty and creates more vibrant markets and wealthier consumers, more household resources are available for other consumer items, providing new trade and investment opportunities. Many US companies see a bright future in developing countries.¹⁴

At the same time, the US role in agriculture encourages creative public-private partnerships with America's land-grant universities, other research universities, research institutions, and NGOs, leveraging government investments with far greater private contributions. The reverberations of these investments are global. Just as similar investments in the 1950s led to scientific breakthroughs that seeded the Green Revolution in the 1960s, today's investments in science to advance food security will have broad-reaching benefits at home and abroad.

The United States has demonstrated strong leadership in prioritizing global agricultural development and food security, while raising its visibility at international summits. Much as President George W. Bush's leadership in public health through Emergency Plan for Aids Relief (PEPFAR) program has improved US standing among developing countries, President Obama's stronger US leadership to alleviate hunger and poverty through agricultural development will enhance US influence. Africa alone represents 28 percent of the UN's member countries.¹⁵

Action is needed now, even in tough fiscal times

Feeding the world is only going to become more difficult. The evidence suggests unless the public sector funds a renaissance in agriculture and food science and the tools needed to get these innovations to farmers around the world, especially smallholder farmers, it may not be possible to meet future demand for food, much less do so in a way that preserves the environment and resources for generations to come. Even at this time of fiscal crisis, the US government must increase its funding for agriculture and food security.

This report puts forward four broad policy recommendations composed of 21 specific actions to define the next steps of US global food security policy. If carried out, these actions would be the catalyst for significant additional support for global food and nutrition security. The strong commitment of the US Congress, the president, vice president, and cabinet officers will be critical to the success of this effort.

Part II—A Blueprint for Action

Recommendation 1—Make global food security a high priority of US economic and foreign development policy

- Action 1A—Congress should commit the nation to a global food and nutrition security strategy

- Action 1B—The vice president should oversee the US government’s global food and nutrition security strategy
- Action 1C—Sustain global food and nutrition security funding and increase resources for scientific collaboration and capacity building
- Action 1D—The United States should urge the international community to prioritize food and nutrition security goals in the post-2015 development agenda

Recommendation 2—Forge a new science of agriculture based on sustainable intensification

- Action 2A—Establish a National Science Commission on Global Food Security chaired by the vice president
- Action 2B—Revitalize US agricultural research capacity by doubling funding over 10 years
- Action 2C—Pass legislation to enhance the science of food security
- Action 2D— Strengthen support for international research institutions
- Action 2E—Increase funding for partnerships and educational exchanges between universities in the United States and universities in the developing world
- Action 2F—Encourage donors as well as developing countries to make food security science a priority

Recommendation 3—Reinvigorate trade as a food security and development tool

- Action 3A—Identify and address barriers to trade and agricultural development
- Action 3B—Use regional trade pacts to increase trade opportunities
- Action 3C—Empower regional economic communities to reduce trade barriers
- Action 3D— Incorporate Africa Trade Hubs into Feed the Future
- Action 3E—Congress should begin work on reauthorizing the African Growth and Opportunity Act and include provisions that will enhance agriculture and food security
- Action 3F—Make food aid more efficient and cost-effective to save more lives and improve food security

Recommendation 4—Make market access and partnership with business a pillar of food security policy

- Action 4A—Incorporate the voice of business in US approaches and country development strategies
- Action 4B—Support developing countries in reforming property rights and land tenure
- Action 4C— Utilize the Millennium Challenge Corporation, the World Bank, and regional development bank resources for rural infrastructure projects

- Action 4D—Capitalize on OPIC to advance the US global agricultural development and food security activities
- Action 4E—Support the work of social entrepreneurs

These recommendations make suggestions for how to maximize current resources for agricultural development, food security, and agriculture and food research. It also recommends a doubling of US investment in agricultural research over the next decade, from \$3.7 billion to \$7.4 billion per year by 2023. This would amount to a steady increase of approximately \$370 million each year between now and 2023. It also recommends greater support for international and national agricultural research institutions by raising funding for US global agricultural development programs over the next decade, from \$1.1 billion to \$1.5 billion per year by 2023. This would be an increase of approximately \$38 million each year between now and 2023.

The architects of this proposal well understand that the federal debt crisis makes this a difficult time for Congress to increase spending on anything. But the consequences of inaction put America's economic and national security interests—and its ability to ensure a safe, affordable, and nutritious food supply for its citizens and others around the world—at such risk that making these investments now is the most financially prudent course of action. And, these investments will have a high rate of return for American farmers, business, and consumers

Recommendations have American bipartisan and public support

The American people will offer strong support for this initiative. A 2012 survey by The Chicago Council on Global Affairs indicated that 91 percent of Americans believe that fighting world hunger should be an important US foreign policy goal.¹⁶

Political leaders on both sides of the aisle firmly believe defeating hunger is often the key to winning peace. Presidents George W. Bush and Barack Obama made development initiatives that advance health and food security hallmarks of their administrations. Secretary of State John Kerry addressed the indelible link between food security and peace when he was chairman of the US Senate Committee on Foreign Relations. Finally, Senator Pat Roberts, a Republican from Kansas, explained the stakes behind the race to feed humanity in his statement on the occasion of the US Department of Agriculture's 150th anniversary.

More than 40 years after Iowa-born plant breeder Norman Borlaug, who was awarded the Peace Prize in 1970 for his role in the Green Revolution, warned that gains of the revolution would ebb away “if we become complacent and relax our efforts,” science must rally again to the challenge of feeding the world.¹⁷ How to reinvent agriculture so that this fragile planet can nourish future generations is a challenge worthy of the greatest political, business, and scientific institutions. The recommendations in this proposal align America with the forces of positive change to meet the most basic of human needs and the loftiest of human aspirations.

A man wearing a green polo shirt, a patterned skirt, and a hat with a stick through it stands in a muddy field, herding several cows. The cows are of various colors, including brown, black, and white. The background is a steep, eroded earthen bank.

PART I

Challenge and Opportunity: Advancing Global Food Security through Agricultural Development

Global food security is a challenge for America



The US government should mobilize science, increase trade, and capitalize on the power of business to tackle what is emerging as the greatest innovation test facing our generation: feeding humanity nutritiously.

Already, almost 870 million people are chronically hungry.¹⁸ Yet economists forecast that the global demand for food will increase 60 percent by 2050 as incomes and population rise.¹⁹ The growing appetite for grain-fed meat and milk among the new middle class in emerging nations such as China, the use of grain to make fuel in developed countries such as the United States, and a world population that is expected to grow by another two billion people all mean that the world's farmers will need to produce as much food over the next 40 years as in thousands of years to date.²⁰ It is far from clear they can.

With agriculture currently consuming 70 percent of fresh water, experts say there will not be enough water to produce all the additional food needed in the coming decades at the rate global agriculture consumes water now.²¹ At the same time, the rise in temperatures and changes in rainfall patterns predicted across the world threaten the productivity of crops.²²

If future generations are to be fed, the global production of nutritious foods will need to improve. Done the right way, increasing food production worldwide would also raise the incomes of many of the world's hungry people: smallholder farmers in Africa and South Asia.* That would drive the economic development that creates new markets and social and political stability.

Many farmers, however, do not have access to the innovations or know-how that will allow them to produce higher quantity, quality, and diversity of food with ever-fewer resources as they adapt to climate change. This is a two-pronged problem. First, the world's scientists do not have the funding or capacity to develop the innovations that farmers need in order to cope with these unprecedented challenges. Despite significant spending on research and development by the private sector, public support of agricultural research has languished, as has the pace of innovation needed to meet future challenges.

Second, even existing practices and innovations that can increase food production are not making their way into the hands of the majority of the world's farmers. Food production in most low-income countries has not kept pace with population growth²³ and is far behind production per hectare in high- and middle-income countries.²⁴ Innovations and approaches need to first be adapted to local conditions, taking into account agroecological factors and cultural preferences, and then made available so farmers have the tools needed to increase agricultural production in a way that advances food and nutrition security, environmental sustainability, and economic growth.

As the world's leading agricultural power, the opportunity for the United States to lead the world in addressing food security is immense. The United States still possesses the most successful agricultural research enterprise in the world through its universities, research institutes, and agribusinesses. The US government can demonstrate international leadership and spur progress by adopting a science and trade strategy for global food security that leverages the power of these world-class institutions, a blueprint for which is included in this report.

Adopting this strategy would be a significant step toward equipping the global agriculture and food system to sustainably meet future demand. With the right partnerships with other governments and organizations in the developed and developing world, the nearly 870 million people that are currently living in chronic hunger—the majority of which are smallholder farmers living in Sub-Saharan Africa and South Asia²⁵—can get the tools needed to lift themselves from poverty and become part of the solution to meet future food demand. The strategy also would create more American jobs, expand trade, and increase US influence globally by leading the world toward food security.

Without a comprehensive strategy, attempts to meet future food demand could falter, progress toward reducing global poverty may halt, and America's domestic and international interests may be put at risk. Hunger would sow more conflict and political unrest in parts of the world that are vitally important to US interests. The number of those living in chronic hunger would increase. The United States could miss the opportunity to cultivate new markets in developing countries. The American farm belt—one of the strongest parts of the economy—could lose export opportunities and see its future prospects dim.

*Smallholder farmers are defined by the World Bank as those with a low asset base operating on less than two hectares of cropland.



Finbarr O'Reilly/Reuters

“Poverty continues to be the most significant determinant of food access in many parts of Liberia although 70 percent of the population depends on agriculture. Recognizing that agricultural growth is more effective in reducing poverty than any effort in any other sector, our government is placing emphasis on this strategic sector both in terms of exports and food security at home.”

Ellen Johnson Sirleaf, President of Liberia, 2012

The US government has the opportunity to be the catalyst for a historic accomplishment. Despite the growing challenges of feeding the world, this generation of scientists, farmers, and business leaders has within its grasp the ability to conquer chronic hunger if given the means, removing a scourge that always has overshadowed humanity. The US government can rally the international community to this innovation challenge.

The world needs a new US agenda for global food security focused on science, trade, and business

This report calls for Washington to make agricultural innovation a priority on its international and domestic agenda. It asks Congress and the White House to give America's public research system a new mission: to reinvent US and global agriculture so that it is far more productive, sustainable, nutritious, and resilient to setbacks, a concept called ***sustainable intensification*** (see box 1). To do this, the government should provide agricultural science the support it needs to fully deploy tools such as conventional breeding, hydrology, and conservation tillage as well as to take full advantage of an exploding array of new tools such as bioinformatics, geographic information systems, molecular breeding, biofortification, irrigation technology, and biotechnology.

Box 1 – What is sustainable intensification?

Sustainable intensification equips farmers with the innovations to:

- increase production of nutritious foods, bringing higher incomes to smallholder farmers,
- conserve land and water with efficient and prudent use of inputs,
- improve human health through accessible food that is nutritious,
- adapt to climate change,
- reduce environmental impact,
- reduce food waste along the supply chain.

The tools to carry out sustainable intensification will be different depending on the location, but the principles are the same.

Source: Adapted from the Montpellier Panel 2013.



Science will have to attract the brightest minds to work on food security for this endeavor to succeed. In an age in which business is collectively spending more on agricultural and food science than governments, the public sector must still conduct the basic and other critical research on which the private sector relies but does not have sufficient incentive itself to conduct.

Science has made it possible for billions more people to live in this world. Much of that effort has focused on helping farmers learn how to use inputs such as pesticides and fertilizer to raise their yields of corn, wheat, and rice—crops that now supply most of humanity’s calories. Indeed, wheat alone sustains 1.2 billion people.²⁶ In spite of this, the food system of the future will need to be more flexible. It is becoming risky to have humanity depend so heavily on so few crops. The range of crop varieties grown around the world today is so narrow that a single plant disease can cause a food crisis. For example, most of the commercial wheat grown in the world today is susceptible to Ug99, a highly-virulent strain of wind-born stem rust sweeping across eastern Africa and the Middle East. Scientists are in a race to get resistant lines of wheat to farmers before the disease spreads to US shores, a distinct possibility.²⁷

A central tenet of sustainable intensification is that agriculture must be more diverse in order to absorb shocks such as climate change and rising fossil fuel prices and to fight hidden hunger, caused in part by the lack of essential micronutrients in staple crops consumed by the poor. This means agricultural science in the United States and abroad needs to adopt a global perspective, cast its net more widely, and be bolder. Among other things, science needs to improve cultivars for far more types of crops, help farmers retain rainwater more effectively, and tailor more of its research to the needs of women, who have been largely neglected even though they do roughly half the farming in Sub-Saharan Africa.²⁸

Production by women who farm in the developing world would climb by 20 to 30 percent if they had the same access to resources men do, according to the Food and Agriculture Organization of the United Nations (FAO). The benefit would ripple throughout society because women there tend to spend more of their additional income on education for children, clothing, and health.²⁹

Likewise, society would benefit greatly from the delivery of labor-saving practices to female farmers, who have overwhelming farm and child care responsibilities. Indeed, it is this duty to children that make women particularly open to approaches that improve nutrition and reduce food waste and storage losses.

Global food security is advanced when scientists help hungry regions such as Sub-Saharan Africa and South Asia maximize their agricultural potential (see box 2). These regions are agriculture’s last untapped frontiers. Their isolation from science and productivity-enhancing methods—including low-technology and no-technology options—not only condemns hundreds of millions of people to chronic hunger, it denies global markets a tremendous source of food. When these regions are helped, the need for direct food aid will decrease.

The path to ending poverty in much of the world runs through the farm (see box 3). Agricultural development is at least twice as effective at reducing poverty as any other sector in the developing world.³⁰ In his 2013 State of the Union, President Barack Obama established a goal of working with allies to eradicate extreme poverty over the next two decades.³¹ The US government cannot hope to reach that goal without helping to

Box 2 – Unlocking the economic importance of Africa

Between 2000 and 2010, six of the 10 fastest-growing economies were in Sub-Saharan Africa. Regionally, Africa has grown faster than East Asia for eight of the past 10 years.

Consider these facts about Africa today:

- Since 2000, 316 million people signed up as new mobile phone subscribers in Africa.
- Africa holds 60 percent of the world's total amount of uncultivated, arable land.
- Fifty-two cities in Africa have populations of over one million people.
- Twenty African companies have revenues of at least \$3 billion.
- Africa's collective GDP, at \$1.6 trillion in 2008, is now roughly equal to that of Brazil or Russia.

Studies suggest that this strong economic growth will continue and that the long-term economic prospects in Africa are quite strong. In particular, four industries could be worth \$2.6 trillion combined by 2020: agriculture, resources, consumer-facing industries, and infrastructure-related industries.

If Africa could overcome agricultural barriers to production—such as lack of advanced seeds and inputs, inadequate infrastructure to bring crops to markets, trade barriers, lack of tax incentives, and unclear land rights—agricultural output could increase from \$280 billion annually to \$880 billion by 2030. Such enormous growth would, in turn, create demand for products such as fertilizer, seeds, and pesticides and create opportunities along the value chain in areas such as grain refining, biofuels, and food processing. Taken together, these additional opportunities could be worth an additional \$275 billion in revenue by 2030.

Sources: *The Economist* 2011; McKinsey Global Institute 2010.

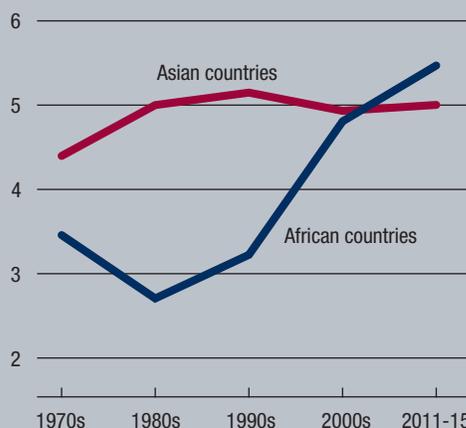
World's 10 fastest-growing economies*

Annual average GDP growth (%)			
2001-2010 (estimate)		2011-2015 (forecast)	
Angola	11.1	China	9.5
China	10.5	India	8.2
Myanmar	10.3	Ethiopia	8.1
Nigeria	8.9	Mozambique	7.7
Ethiopia	8.4	Tanzania	7.2
Kazakhstan	8.2	Vietnam	7.2
Chad	7.9	Congo	7.0
Mozambique	7.9	Ghana	7.0
Cambodia	7.7	Zambia	6.9
Rwanda	7.6	Nigeria	6.8

*Excluding countries with a population of less than 10 million and Iraq and Afghanistan.

Source: *The Economist* 2011.

GDP growth, unweighted, annual average percentage*



*Excluding countries with a population of less than 10 million and Iraq and Afghanistan.

Source: *The Economist* 2011.

boost the income of the poorest by putting more science in the hands of the developing world's smallholder farmers.

Science cannot create global food security on its own. Any drive to rejuvenate agricultural and food research is wasted unless the private and public sectors get these innovations into the hands of farmers, regardless of where they live or their economic status. Likewise, many countries cannot achieve food self-sufficiency because they lack the geography and climate for it. Their food security depends on trade. Only 25 percent of the world's calories cross borders.³² As part of its global food security strategy, the US government should encourage the development of the private sector in the developing world and reenergize its efforts to expand global trade in agriculture.

Action is needed now, even in tough fiscal times

Washington should act quickly—feeding the world nutritiously is only going to get more difficult. In 2013 the world likely will consume more grain than it produces.³³ With the world's buffer against shortages shrinking, food prices have climbed sharply higher around the world, halting progress in further reducing the number of hungry people. Childhood malnutrition is a cause of death for 2.5 million children each year.³⁴ Chronic hunger is mostly prevalent in the developing world—852 million people there are chronically hungry.³⁵

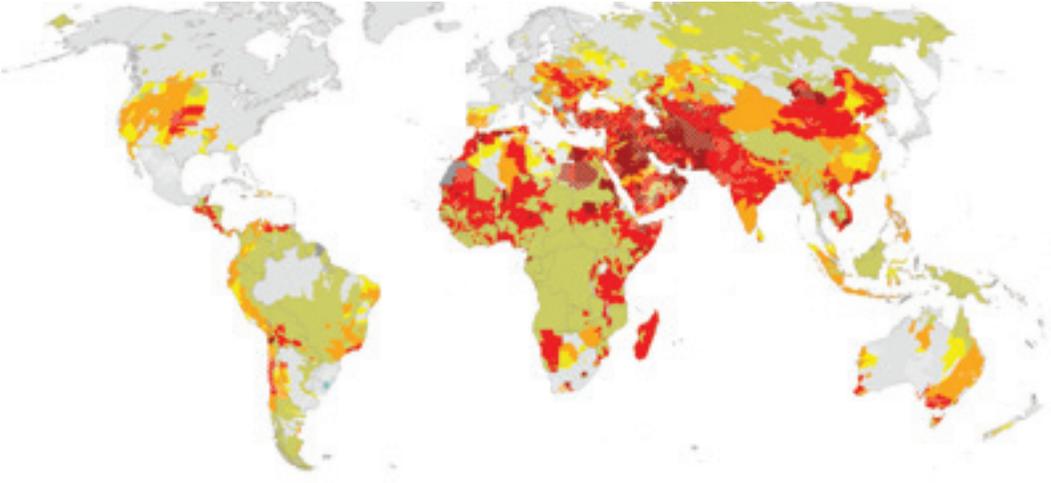


Box 3 – The power of agricultural development

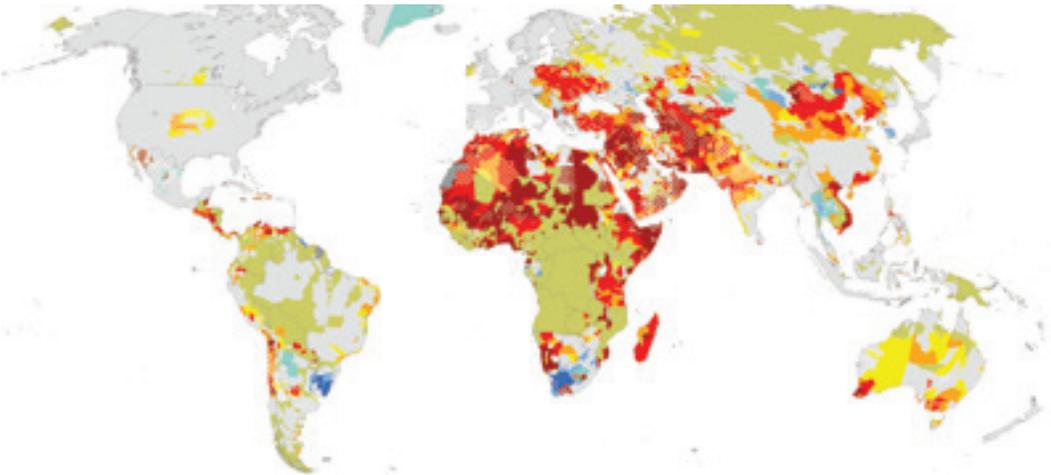
- Growth in agriculture is on average at least twice as effective at reducing poverty as growth in other sectors.
- Economic growth of 1 percent in agriculture generates a 6 percent increase in overall expenditure by the poorest 10 percent of populations.
- In Asia every \$1 in income in the farming sector creates a further \$0.80 in the nonfarm sector.
- With proper investment and use of uncultivated land, agricultural output in Africa could increase from \$280 billion per year to as much as \$880 billion by 2030.

Sources: World Bank 2008; CGIAR 2012; Bell et al. 1982; McKinsey 2010.

Figure 1 – Projected change in water stress—2025



Projected change in water stress—2050



- Exceptionally less stressed
- Extremely less stressed
- Significantly less stressed
- Moderately less stressed
- Near normal conditions
- Moderately more stressed
- Severely more stressed
- Extremely more stressed
- Exceptionally more stressed
- Wetter but still extremely high stress
- Uncertainty in magnitude
- Uncertainty in direction
- Drier but still low stress
- Ocean or inland water
- No data/out of area

Source: World Resources Institute 2012.

At the same time, global agricultural production is not increasing at the same rate as it has in decades past. Water for irrigation and untapped productive land are getting harder and harder to find. Thirty-eight percent of the world’s total land area is already used for agriculture, according to the FAO.³⁶ As a US Department of Agriculture (USDA) expert committee observed:

“Many countries have a limited ability to expand planted area, and the expansion that does occur takes place on land with lower productive capacity. The growth rate in world-average crop yields, especially yields for cereal crops, has been slowing for nearly two decades, to some extent as a result of reduced research and development funding. Water constraints in

some countries are impeding the expansion of irrigation. Where irrigation water is pumped from deep wells, the energy cost of pumping is projected to continue to increase due to falling water tables. Costs of other production inputs such as fertilizers and chemicals are likely to increase” (see figure 1).³⁷

There is a significant productivity gap in regions where the population is growing the fastest, particularly Sub-Saharan Africa.³⁸ The United Nations warns that 25 percent of the world’s farmland is already highly degraded (see figure 2), and climate change will make food production more unstable in the coming decades by upending the places where crops can be grown and by stirring up agricultural diseases and pests.³⁹ Climate change could reduce agricultural productivity by as much as 16 percent globally by 2080 and by as much as 28 percent in Africa.⁴⁰

Charts that track food prices are beginning to look Malthusian because agricultural production is not keeping up with demand. British economist Thomas Robert Malthus argued in 1798 that the ability of people to reproduce faster than farmers can produce food condemns humanity to famines. Thankfully, Malthus underestimated the potential for innovations and technology to boost agricultural productivity at a faster pace than population growth. Agricultural prices adjusted for inflation fell by an average of about 1 percent per year during the 1900s, even as the world population marched upward.⁴¹

Food prices are volatile and, for the most part, increasing

Since the middle of the last decade, however, real prices of raw agricultural commodities have climbed. The FAO’s 2012 index of real food prices—a broad composite of grains, oilseeds, meat, dairy, and sugar—was up 37 percent compared to 2005 (see figure 3).⁴² There is no relief in sight. The International Food Policy Research Institute (IFPRI) projects that the real prices of rice, corn, and wheat will likely rise by 25 percent, 48 percent, and 75 percent, respectively, by 2050 from 2010. IFPRI’s forecast does not

Figure 2 – Global land quality and soil resilience

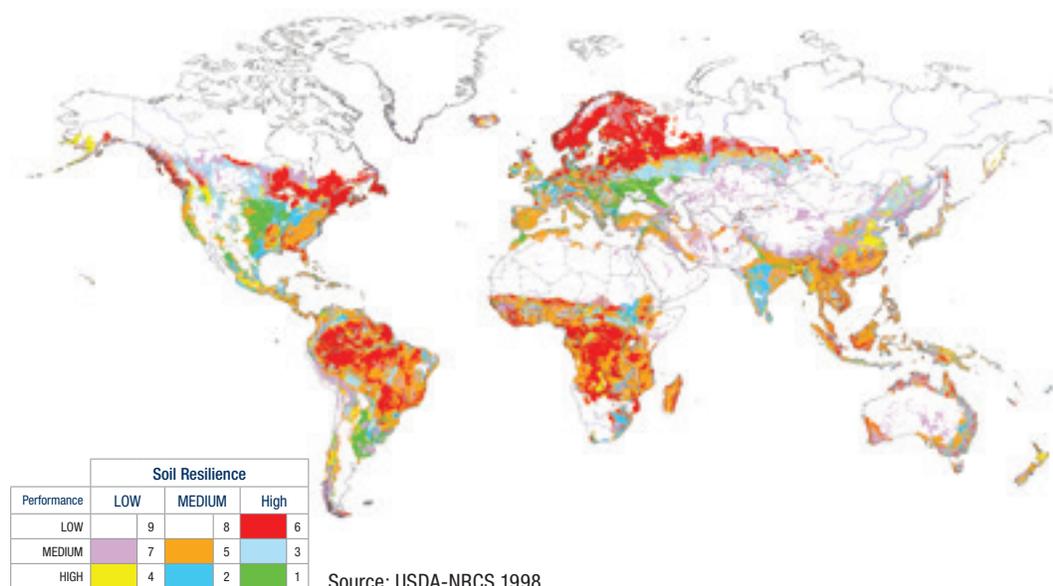
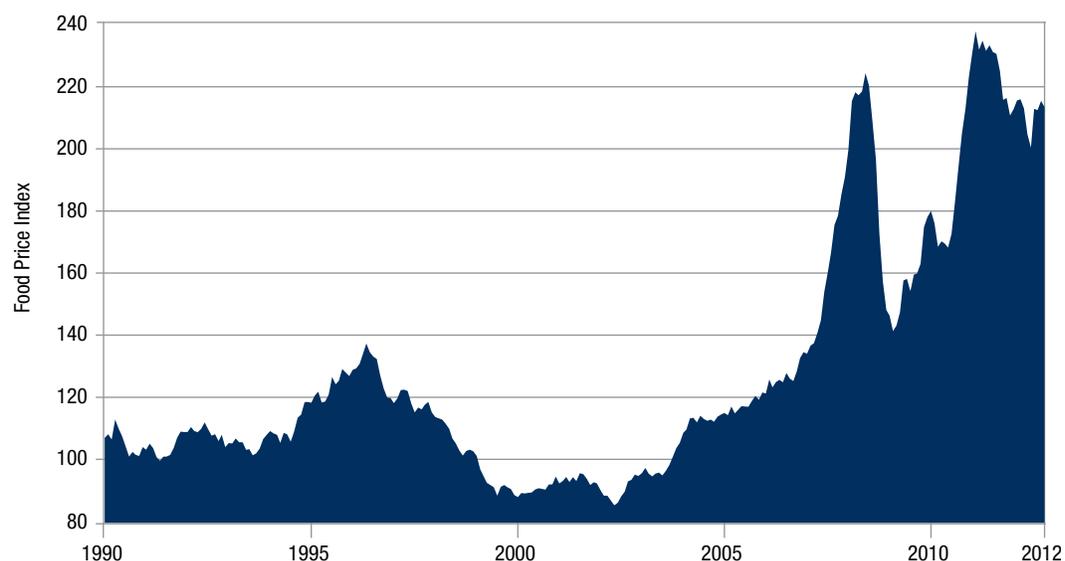


Figure 3 – Food prices, 1990 to 2012



Source: FAO 2013.

include the impact on prices from climate change, which the group figures will further increase the prices of staple foods.⁴³

Grain supplies are already so tight that weather-related disruptions such as droughts and floods now cause panic in the markets and inside governments. Nominal prices of corn and soybeans hit record highs in 2012 amid the US drought.⁴⁴ A drought in the Black Sea region in 2010 prompted Russia to ban wheat exports, triggering an explosive rally in grain prices.⁴⁵ In 2007 several Asian nations tried to ease the burden of rising food prices on their citizens by banning exports of rice. The move backfired—global prices soared even though supplies of rice were ample at the time.⁴⁶

Rising food prices are casting a shadow over one of this generation's great accomplishments. The lives of many of the world's poorest people have improved significantly since 1990 as measured against some of the Millennium Development Goals developed by the United Nations. In 1990, 1.9 billion people, or 43.1 percent of the developing world population, lived in extreme poverty, which means on less than \$1.25 per day. By 2008 that figure had fallen to 1.29 billion people, or 22.4 percent of the developing world population. The World Bank calculates that the prevalence of poverty sank more by 2010.⁴⁷ But the rising cost of food is jeopardizing this progress because many of the world's poor spend between 50 and 70 percent of their income on food.⁴⁸

Street protests, some violent, occurred in roughly 30 countries in 2008 after food prices shot up, and rising food prices were reportedly factors in the popular uprisings of the Arab Spring. While food price hikes alone may not be the cause of unrest or extremism, they can exacerbate existing grievances against unresponsive or unrepresentative governments.⁴⁹ The problem is not just the rise in food prices, but their volatility. It is clear that the agricultural sector is entering a period of great price uncertainty.

Box 4 – The Green Revolution

From the 1950s to 1980s the Green Revolution transformed agriculture around the world through the development of improved crop varieties, specifically wheat and rice, and the widespread adaptation of pesticides, fertilizers, irrigation systems, and other agricultural technologies. In developing countries such as India and Mexico, agricultural productivity nearly doubled during this period. However, while the most growth occurred in Latin America and Asia, parts of South Asia and Sub-Saharan Africa saw few improvements in agriculture due to poor infrastructure, limited investment in irrigation, and diversity in soil types and climate that made new crop varieties inappropriate for these regions.

The Green Revolution was possible as a result of agricultural research, education, and infrastruc-

ture development in developing countries funded both by governments and private foundations. The Ford and Rockefeller foundations established an international agricultural resource system that included the International Center for Wheat and Maize Improvement (CIMMYT) in Mexico and the International Rice Research Institute (IRRI) in the Philippines to adapt high-yield wheat and rice varieties to conditions in developing countries. These new varieties were introduced in Mexico and northwest India in the 1960s and rapidly spread through extension services to other areas with similar geographies and climates. By 1970, 20 percent of wheat areas and 30 percent of rice areas in developing countries were planted with high-yield varieties, and by 1990 these numbers reached 70 percent.

Sources: USDA 2008; Prabhu and Raney 2005; Hazell 2002.



Chicago Council food security initiatives have proven valuable

In the wake of the 2008 food crisis, The Chicago Council on Global Affairs brought together a bipartisan group of leaders and experts in agriculture development, economics, and foreign policy. The 2009 report *Renewing American Leadership in the Fight Against Global Hunger and Poverty* helped call attention to the fact that half of the world's chronically hungry people are trapped in poverty because their farms in Sub-Saharan Africa and South Asia produce far below their potential. These farmers remain cut off from the Green Revolution that four decades earlier brought scientific innovations to farmers throughout the developing world (see box 4).

As part of its report, the Council's leadership group proposed the Chicago Initiative on Global Agricultural Development, a cost-effective and practical US strategy for reinvesting in agricultural development in the world's hungry nations, following the plunge in funding since the 1980s.

Washington acted. President Obama pledged in his first inaugural address that the United States would help farms in poor nations to flourish.⁵⁰ Then Secretary of State Hillary Clinton adopted the plight of the world's hungry as one of her chief causes and helped design the Feed the Future initiative, which mines the expertise of agencies across the federal government.⁵¹ The United States now has a coherent agricultural development strategy backed by expanded congressional funding and talented staff. The US Agency for International Development (USAID), for example, established the Bureau for Food Security.⁵² The Millennium Challenge Corporation increased its funding of projects in Sub-Saharan Africa for agriculture and food security infrastructure.⁵³

Four years later, with President Obama in his second term and a 113th Congress at work, The Chicago Council has brought together a second leadership group to recommend next steps for US global food security. Cochaired by former agriculture secretary Dan Glickman and Catherine Bertini, former executive director of the UN World Food Program, this bipartisan group includes executives of NGOs and corporations, scientists, and policy leaders.

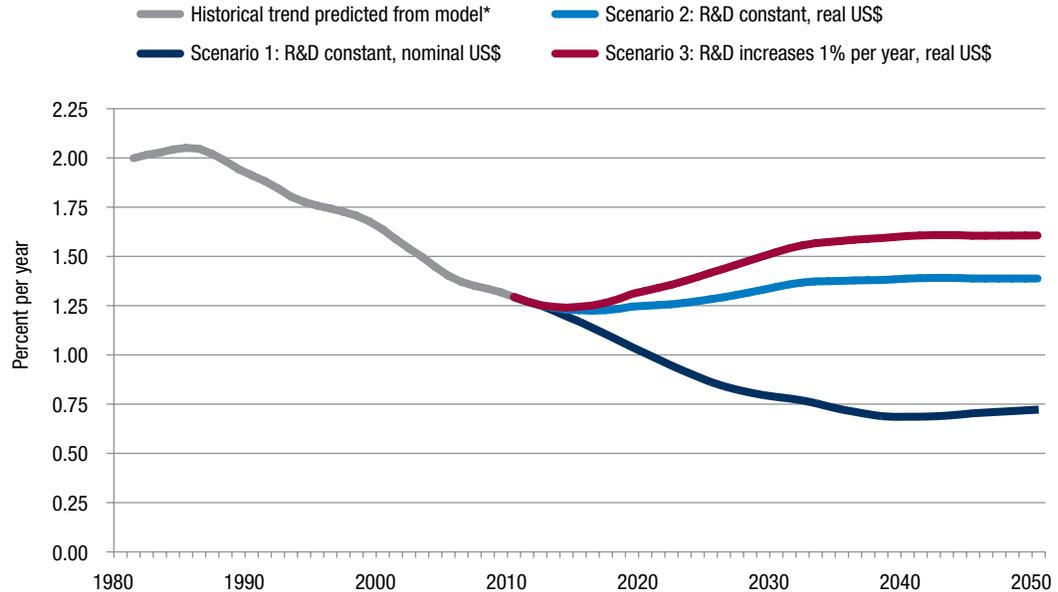
Their conclusion: The United States can build on its efforts over the last four years by setting a new agenda for global food and nutrition security around science, trade, and business. With the leadership of Congress and the president, the US government can more fully leverage its resources by codifying food security as a priority of US development policy tightly aligned to the nation's national security.

Public agricultural and food science must be energized

Most importantly, Washington must recommit itself to a legacy of supporting public agricultural and food research, with global food and nutrition security as the goal. America's support of agricultural scientists is crucial to whether the United States and the world can feed itself in a sustainable way. Given the new challenges facing agriculture, however, it is far from assured that even US agricultural output can climb enough to keep pace with expected demands, let alone be helpful to farmers and consumers in the developing world (see figure 4).⁵⁴

Other experts are concerned as well about the state of US agricultural science. The President's Council of Advisors on Science and Technology warned in December 2012

Figure 4 – US total factor productivity growth rate projections, 1980 to 2050



Total factor productivity (TFP) is the broadest measure of productivity. It compares the total output of a sector to the total land, labor, capital, and material inputs used to produce that output. Increases in TFP imply more output is forthcoming from a given level of inputs or, equivalently, fewer inputs are required to produce the same output. Growth in TFP is considered to be an indicator of the rate of technical change in a sector.

*The graph shows the TFP growth rate predicted from the statistical model rather than the actual TFP growth rate for 1980 to 2008. Actual TFP growth is highly variable, ranging between -15 percent and +15 percent for individual years. This variability is mainly due to weather.

Source: Heisey, Wang, and Fuglie 2011.

that “our nation’s agricultural research enterprise is not prepared to meet the challenges that US agriculture faces in the 21st century.”⁵⁵ Other US groups calling attention to the science gap include the Global Harvest Initiative, National Coalition for Food and Agricultural Research, and the Council of Agricultural Science and Technology.

In addition to requesting that Washington double annual federal funding of public agricultural and food research over 10 years to \$7.4 billion, this second Chicago initiative calls upon the White House and Congress to become far more engaged in the scientific endeavor for global food security. While USAID should continue to be the lead agency for international development, the vice president should chair a commission of members of Congress and of scientists from government, academia, and business charged with setting national priorities for publicly funded agricultural and food research with the goal of global food security. The initiative also suggests how to maximize current resources for agricultural development, food security, and agriculture and food research.

This second Chicago initiative asks the administration to lobby the international community to continue the progress on ending hunger, poverty, and malnutrition as part of the post-2015 development agenda and to work with the G20 to establish a regular annual meeting of their members’ chief agricultural scientists to increase data sharing and align research priorities.

Box 5 – Agriculture and nutrition: The importance of the “1,000 days” window

Proper prenatal health and early childhood nutrition can have a remarkable impact on the immediate well-being of children as well as important long-term consequences for international development efforts. Malnutrition and undernutrition have devastating effects for the millions of children they afflict, increasing the risk of disease and infection and contributing to the deaths of 2.5 million children under the age of five each year. Malnourished children who survive have an increased risk of battling chronic disease as adults, and poor early childhood nutrition often impairs cognitive development, lowers adult productivity, and decreases educational attainment.

These consequences carry substantial economic impact: a country with widespread childhood malnutrition can suffer losses to GDP as high as 2 to 3 percent, even before accounting for higher health care costs or lost wages due to disease. A growing body of evidence shows that the window of opportunity to avert these outcomes is the 1,000-day period between the beginning of pregnancy and a child’s second birthday, after

which the effects of malnutrition are mostly permanent.

More and more stakeholders are recognizing the role that agriculture can play in addressing this “1,000 days” challenge. The Scaling Up Nutrition (SUN) Movement coordinates country-led efforts to employ a nutrition-sensitive agricultural approach, ensuring that children have enough of the right food to concentrate, learn, and prosper in countries like Bangladesh, Ethiopia, Kenya, Nepal, and Niger. The US-based ACDI/VOCA is working in Burkina Faso, Liberia, and Sierra Leone to evaluate agriculture value chains and diversify production with the goal of reducing chronic childhood malnutrition. Through Feed the Future and the Global Health Initiative, USAID supports community-based efforts to improve nutrition by integrating agriculture, gender, nutrition, and sanitation in Senegal and Uganda. The 1,000 Days advocacy hub has convened more than 80 partners, including the aforementioned three, to highlight the importance of early childhood nutrition and promote relevant action and investment worldwide.

Sources: 1,000 Days 2011; Ruel and Hodinott 2008; Scaling Up Nutrition 2013; ACDI/VOCA 2013; Feed the Future 2011.



This report also calls on public researchers to expand the horizons of their work. Given the complexity and enormity of the food security challenge, innovation is needed all along the food chain, from reducing postharvest storage losses to making food more nutritious (see box 5). Many of the world's poor cannot afford to eat the fruits, vegetables, and meat that are rich in essential micronutrients such as vitamin A, zinc, and iron. Such deficiencies are linked to blindness and stunted growth in children. Plant breeders should put as much value on raising the level of these nutrients in crops eaten by billions of the world's poor—such as corn, wheat, sorghum, legumes, and rice—as they do on raising yields.

Advancing global food security will require significantly more location-specific research and investigation of all available practices and innovations—whether high technology, low technology, or no technology (see box 6). Which agricultural practices are nutritious, sustainable, and productive depend on agroecological conditions, local diets, culture, and financial resources. This new scientific endeavor will need to put much more energy into developing and disseminating solutions that work for farmers everywhere, but especially those in low-income regions where agriculture is underproducing.

Trade and business must be invigorated

On the trade front, the United States should work harder to make the unfettered movement of food and agricultural commodities a higher priority on its international agenda. The ability of food to flow across borders is one of the most important mechanisms the world has for coping with a food crisis. This will only become more important as the population grows and more and more food will need to move from areas of surplus to those of deficit. The desire of many countries to insulate their politically sensitive farm sectors from competition is a major reason that the Doha trade talks—which would have used trade to lift the world's poorest economies—have not yet succeeded.

Global food security cannot be achieved without the involvement of the private sector. Business carries out slightly more than half of all the food and agricultural research conducted in high-income nations, which is where the vast majority of the world's research is done.⁵⁶ Harmonizing regulatory systems and ensuring agriculture and food commodities flow freely will better facilitate business enterprise. In addition, the government must focus on infrastructure and research investments that pave the way for the private sector to bring innovations to the marketplace on a large scale.

Innovations will need to reach farmers globally, from the high-tech farms on the American Great Plains to the parts of the African savannah where farming has changed little for centuries. The agricultural potential in Sub-Saharan Africa is largely untapped and if realized would play a significant role in meeting future agricultural demand. The vast tropical savannahs of Sub-Saharan Africa can no longer be viewed as inhospitable for agriculture.⁵⁷

Likewise, the women who farm in Sub-Saharan Africa have the potential to produce far more food from their fields if scientists and development specialists think more about how to empower them with knowledge, technology, and resources. A focus on female farmers could increase agricultural output in developing countries between 2.5 and 4 percent, according to FAO research. Increasing production by this amount could reduce the number of undernourished people on the order of 12 to 17 percent.⁵⁸

Box 6 – The power of agricultural research

- Investments in agricultural research have an average rate of return of 9.9 percent.
- Agricultural research currently reduces the number of poor by 2.3 million or 0.8 percent annually.
- Investment in research, often associated with extension, is found to be the primary driver of productivity growth in agriculture.
- R&D investments often have the largest effect on sectorial growth, especially when considering long-term impact. In terms of poverty reduction, R&D investments are often stronger and more stable than other types of agricultural spending.
- Many studies during the late 20th century show that the internal rates of return (IRRs) to investments in agricultural research are more than 20 percent. Four in ten of the estimates found IRR to be greater than 60 percent. The highest IRRs were recorded in Asia, Latin America, and Africa.
- In Rwanda for every dollar of additional government spending on agricultural research, the agricultural GDP increases by \$3. However, the effects were larger for staple crops like maize, cassava, pulses, and poultry than for export crops.
- For golden rice in the Philippines, calculations of the internal rate of return for biofortification project investments range from 66 to 133 percent.
- In Indonesia crop growth has responded strongly to technology investments. Eighty-five percent of rice growth, 93 percent of cassava growth, and 71 percent of soybean growth can be attributed to investments in research, extension, and irrigation.

Sources: Alston et al. 2011; Alene and Ousame 2009; Fischer, Byerlee, and Edmeades 2009; FAO 2012; IFPRI 2012; Zimmerman and Qaim 2004; IFPRI 2012.



Washington has a legacy of support for agriculture

US farmers have such an extraordinary record of productivity that there is good reason to believe they can meet the food security challenge if given the innovations for sustainable intensification. The US farm sector was able to produce five times as many crop and livestock products in 2007 as it did in 1910 on less and less inputs. While output grew 1.74 percent annually over the period, the consumption of inputs climbed just 0.15 percent per year.⁵⁹

Extensive research shows this productivity was built on a strong foundation of public investment that began when the nation was young. In 1862 President Abraham Lincoln signed bills that created the land-grant university system as well as the US Department of Agriculture, from which later would spring the Food and Drug Administration and the Environmental Protection Agency. In 1940 the federal government spent more on agriculture and rural development than defense, making the category second only to spending on commerce and transportation.⁶⁰

US farmers now make up just 1 percent of the US population, compared to about 25 percent in the 1930s, freeing millions to take nonfarm jobs that have expanded the diversity of the US economy.⁶¹ They grow enough to supply domestic markets and, in years with good weather, export roughly half their wheat and rice and more than 40 percent of their soybeans.⁶² Nearly 40 percent of the US corn crop is consumed by the ethanol industry.⁶³ Americans spend less than 10 percent of their disposable income on food, compared to 25 percent in the 1930s, and far less than consumers spend now in Europe, Asia, and Africa.⁶⁴ Thanks to agricultural science, US consumers have saved billions of dollars on their food bills.

Complacency must be attacked

The problem is that US farmers' success has bred complacency about the challenges of feeding the world. Federal spending on agricultural research has been largely stagnant for three decades and even slipped in recent years when the figures are adjusted for inflation.⁶⁵ What's more, research funds are being diluted by new priorities such as food safety and finding industrial applications for crops. These are important investments, but should not detract from basic scientific needs. China, meanwhile, has leapt past the United States as the biggest funder of public agricultural research.⁶⁶

In the United States the private sector has been expanding its spending on research and development of agriculture and food, thanks in part to the crop biotechnology boom. But private-sector spending alone is not enough to get US farm productivity growing at the necessary rate. US farm yield measured by total output grew by just half as much after 1990 as it did from 1950 to 1989.⁶⁷ Many private companies cannot afford to invest in research unless there is a clear path to profits, which often limits their interest to bringing only existing technologies to market. Private companies tend not to invest in research on basic problems or long-term challenges such as predicting the effects of climate change and equipping nonstaple crops to adapt to it.⁶⁸

What's more, private-sector research is aimed at a narrow slice of high-income farmers. Most of the world's farmers are poor and live in the developing world. For example, there is little incentive for the private sector to employ biotechnology—which includes both traditional breeding and genetically modified seeds—on most of the

world's crops. The cost of bringing a transgenic plant to market can easily exceed \$100 million, and few seed markets are big enough to support that cost.⁶⁹ US farmers of hybrid corn have been a rich market for the biotechnology industry because they are able to pay significant premiums for seeds that grow into plants that resist pests or produce an industrial enzyme. Privately funded crop biotechnology does not compute for smaller crops such as most of the vegetables grown in the United States or crops that farmers grow from seeds saved from their harvests, which is frequently the case in Africa. Biotechnology for the smallholder farmer, be it crops that resist pests or survive drought, requires public involvement.

Public investments in agricultural research do not just fuel scientific breakthroughs—they are the means to train the next generation of agricultural and food leaders. While the commodity price boom is attracting more students to agricultural studies at land-grant universities, companies still report difficulty finding enough graduates for their laboratories.

Science is a wise and necessary investment, even in tough fiscal times

The evidence suggests that unless the public sector funds a renaissance in agriculture and food science and provides the tools needed to get these innovations to farmers around the world, it may not be possible to meet future demand for food, much less do so in a way that preserves the environment and resources for generations to come. Even at this time of fiscal crisis, the US government must increase its funding for agriculture and food security. Not only is this increase essential to meeting future food demand, it benefits American national security and cultivates new markets for agricultural and other goods.

Agricultural research is an investment that pays for itself. Study after study around the world shows that public spending on agricultural science generates very high rates of return for consumers and farmers. In the United States, each dollar spent on public agricultural research generates roughly \$10 worth of benefits for the economy.⁷⁰

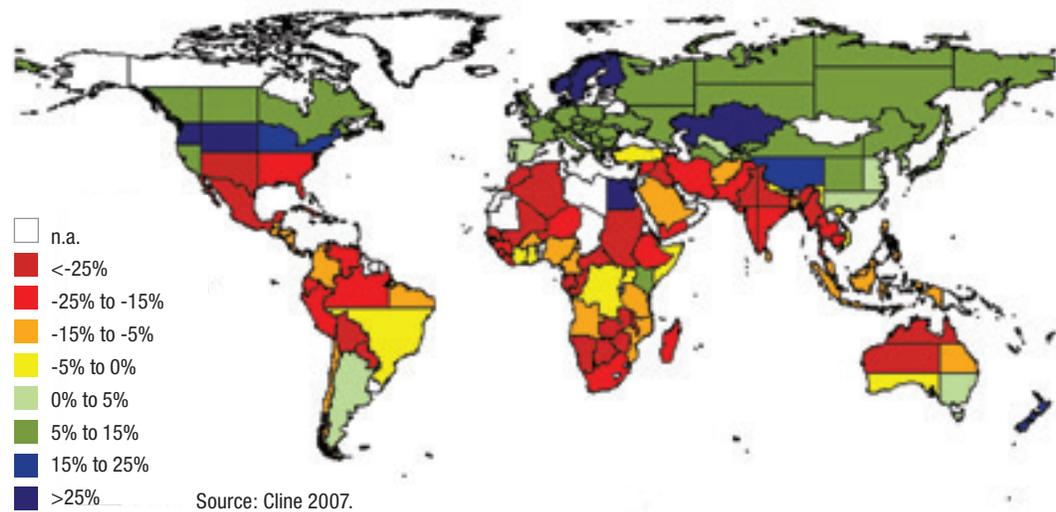
US farmers need science in order to thrive

Science will determine not only whether America's farmers can rise to the challenge of feeding the world, but whether they themselves can thrive. The reality of climate change means US farmers need help figuring out how to adapt their operations to changes in temperature and precipitation, which will have ripple effects on everything from the amount of solar radiation for photosynthesis to the life cycles of insects that pollinate our crops. The USDA's plant hardiness zones—which guide farmers on what and when to plant—are already marching north.⁷¹ Climate forecasts need to become more practical for farmers by becoming more precise in terms of scale and scope. An Illinois farmer is not helped much by a forecast over a sprawling region for several decades from now. Likewise, science needs to give farmers a lot more information about the sensitivity of crops and livestock to climate change (see figure 5).

Beyond climate change, US farmers need innovation in order to sustain their land for future generations. For example, they need help protecting their most precious natural asset, the soil, from erosion. An Iowa farmer who cultivates his land loses an

Figure 5 – The impact of climate change on agricultural productivity

Projected changes in agricultural productivity in the 2080s due to climate change, incorporating the effects of carbon fertilization



average of 1.3 pounds of soil for every pound of corn he produces.⁷² On the Great Plains, meanwhile, farmers have been unable to stop their inexorable draining of the Ogallala Aquifer, without which their grain yields will plunge.⁷³

The rapid spread of herbicide-resistant weeds is forcing southern farmers to return to using harsher herbicides from the past. The Mississippi River is so loaded with fertilizer runoff from Midwest farm fields that it creates a “dead zone” where it dumps into the Gulf of Mexico. The excessive level of nitrogen and phosphorus in the water causes the algae population to explode. The algae consume so much oxygen from the water that marine life abandons the area. According to the National Oceanic and Atmospheric Administration, the dead zone was roughly the area of Delaware in 2012.⁷⁴ Farmers will face increasing regulation unless science finds more ways for them to keep the soil and chemicals from leaving their fields.

Agricultural and food science can lift the developing world

Not only does the languishing of research dollars for research affect domestic production, but this report reaches the equal conclusion that the low level of US funding for research aimed at helping smallholder farmers in the developing world grow more food is risky. While funding has increased since 2009, federal support is still one-third of what it was during the 1980s. When calculated in 2005 dollars, USAID spent \$94 million on supporting global agricultural research at international and national agricultural research institutes in 2011, compared to \$306 million in 1985.⁷⁵

This funding is crucial because so little science reaches these farmers, forcing them to scratch out a living from their tiny plots in much the manner as generations did before them: by hand with a hoe and machete. Sub-Saharan Africa's cereal yields are half the global average.⁷⁶ Poverty often stands in the way of science reaching them. Yet science is a particularly cost-effective way for the US government to help build food security in places such as Sub-Saharan Africa (see box 7).

Box 7 – A focus on smallholders and women can raise productivity and reduce poverty

While farmers of all sizes and in all nations will need to grow more to meet future demand, perhaps the greatest potential for increasing production lies in Africa, where low-yield smallholder farms predominate. Eighty percent of farmers in Africa are smallholders, many working on less than two hectares of land. With greater access to a full range of technology, finance, functioning markets, and improved governance frameworks that emphasize property rights, transparency, and accountability, their productivity gains will help feed the world.

A focus on smallholders would also significantly reduce poverty. Increasing their productivity and incomes will strengthen their buying power, which will in turn help local businesses create more nonfarm jobs and income opportunities. This will contribute to revitalized rural economies that will dampen the “push” factor in rural to urban migration.

Designing programs for the benefit of smallholders requires being sensitive to the challenges they face. The precarious position of smallholders makes them vulnerable to being buffeted by investments in large agricultural enterprises. While this report recommends improving the enabling environment for increased private investments, attention should be given to those investments that also benefit smallholders. Farmer associations and cooperatives are proven models for empowering smallholders. The challenges of feeding the world and reducing poverty require investments along a full spectrum of agricultural enterprises.

Approaches that incorporate a risk mitigation component may increase the adoption rate of new technologies that small farmers would otherwise be hesitant to embrace. Smallholders are risk averse. Dire levels of poverty give them less ability to recover from a failure, so one miscalculation can be catastrophic. In addition to risk mitigation measures, increasing the body of evidence on

what works best and in what contexts is important to raise the confidence level of farmers to take manageable risk. The sustainable intensification of agriculture must include building the resilience of smallholders.

Smallholders should have equal access to a full array of technology. Scientific progress need not be measured by the sophistication of scientific and technological breakthroughs. Some of the simplest of technologies such as the treadle pump can raise farm yields for smallholders with minimal investment and maintenance costs. Utilizing a full range of technologies, from the most sophisticated to the traditional, depends on the context. In the final analysis, technology must be appropriate if it is to be widely adopted.

Results can be amplified with focus on gender and youth

Interventions to promote productivity can be amplified and sustained by being more inclusive of youth and gender differences. Attention to the roles of men and women in farming families is a critical component to empowering farmers to be more productive. Women and girls make up roughly 43 percent of the world’s agricultural labor force, but often lack the same inputs—in the form of finance and access to technology—than their male counterparts. Cultural norms may limit women’s access to male-dominated business and extension services. While men may be able to more easily avail themselves of extension services, for example, women often have less discretionary time to do so as the primary caregivers of the family and the primary workers in the field.

In many parts of the world, men and women have different farming roles, often within the same family. Men tend to staple crops that are sold for income, while women take care of gardens and small livestock for family sustenance. A focus



IFDC

exclusively on one or the other could be harmful. Sensitivity to the roles of men and women in their specific cultural contexts is important in order to design programs that reach both effectively.

Evidence has shown that when programs are designed to include women, productivity increases and the benefits are amplified throughout the family unit. The FAO estimates that “bringing yields on the land farmed by women up to the levels achieved by men would increase agricultural output in developing countries between 2.5 and 4 percent. Increasing production by this amount could reduce the number of undernourished people in the world in the order of 12 to 17 percent.” The FAO finds that closing the gender gap could reduce the current number of impoverished people by 100 to 150 million.

Investing in women can provide a strong link between agriculture and nutrition. Studies show

the long-term value in improving nutrition during the first 1,000 days, from the beginning of pregnancy to age two. Studies also indicate that women spend a greater portion of their incomes on providing better nutrition for their families and sending their children to school. Better nutrition results in higher productivity both at work and school and reduces the probability of chronic health conditions.

Youth need to find agriculture an attractive and productive career path. The United Nations reports that 60 percent of the population of developing countries is under the age of 25. This so-called youth bulge will create demand for more jobs, which, if left unaddressed, could contribute to social unrest in many countries. Agriculture can be the basis for revitalized economies and job creation that is both farm and nonfarm related.

Sources: ESFIM 2012; IFPRI 2011; FAO 2001; FAO 2011; FAO 2012; Meinzen-Dick 2011; Srinivas 2004; Torero 2013.

Here's why: Roughly half of the world's hungry live in smallholder-farming households. These farmers cannot produce enough from the land to feed their families, let alone sell to local markets for income.⁷⁷ Getting smallholder farmers to the point where they can produce enough food for themselves, and then some, could do more to reduce the numbers of people mired in hunger and poverty than anything else we can do. Agricultural productivity has power both to bring down food prices for the urban poor and to increase the incomes of smallholder farmers.

Global food security is in America's economic interests

The United States helps itself by helping spur agricultural development in poor regions of the world. For one thing, agricultural development plants the seeds for future trading partners. History shows that farm productivity aids in transforming a poor country into a developed country. One of the first steps that China took to becoming a free-market economy was to move away from collective agriculture in 1978. Food production rose because farmers know a lot more about farming than central planners, a discovery that was followed by broader market reforms. Today, China has a vast middle class that is

We can never guarantee our security through military means alone. True security requires a far broader approach, using nonmilitary means to reduce threats before they gather strength. And this is especially true of our strategic interest in fighting disease and extreme poverty across the globe.

Senator John McCain (R-AZ), 2008



among the biggest customers of the US farmer. China buys about one-quarter of all the soybeans grown in the United States, and many grain traders believe that China will in this decade become the biggest foreign buyer of US corn, surpassing Japan.⁷⁸

Likewise, agricultural development in Africa would create new markets for American business. Nine of the ten economies projected to grow the most in the next five years are in South Asia and Sub-Saharan Africa.⁷⁹ Agriculture is either the largest sector or the activity on which the most people depend for their livelihoods in many of these economies. As growth in agriculture reduces hunger and poverty and creates more vibrant markets and wealthier consumers, more household resources are available for other consumer items, providing new trade and investment opportunities. Many US companies see a bright future in developing countries.⁸⁰

At the same time, the US role in agriculture encourages creative public-private partnerships with America's land-grant universities, other research universities, research institutions, and NGOs, leveraging government investments with far greater private contributions. The reverberations of these investments are global. Just as similar investments in the 1950s led to scientific breakthroughs that seeded the Green Revolution in the 1960s, today's investments in genetic and agricultural sciences will have broad-reaching benefits at home and abroad.

The United States has demonstrated strong leadership in prioritizing global agricultural development and food security, while raising its visibility at international summits. Much as President George W. Bush's PEPFAR program has improved US standing among developing countries, stronger US leadership to alleviate hunger and poverty through agricultural development will enhance US influence globally, especially in regions that will become increasingly important strategically in years ahead. Africa alone is home to 28 percent of the UN's member countries.⁸¹

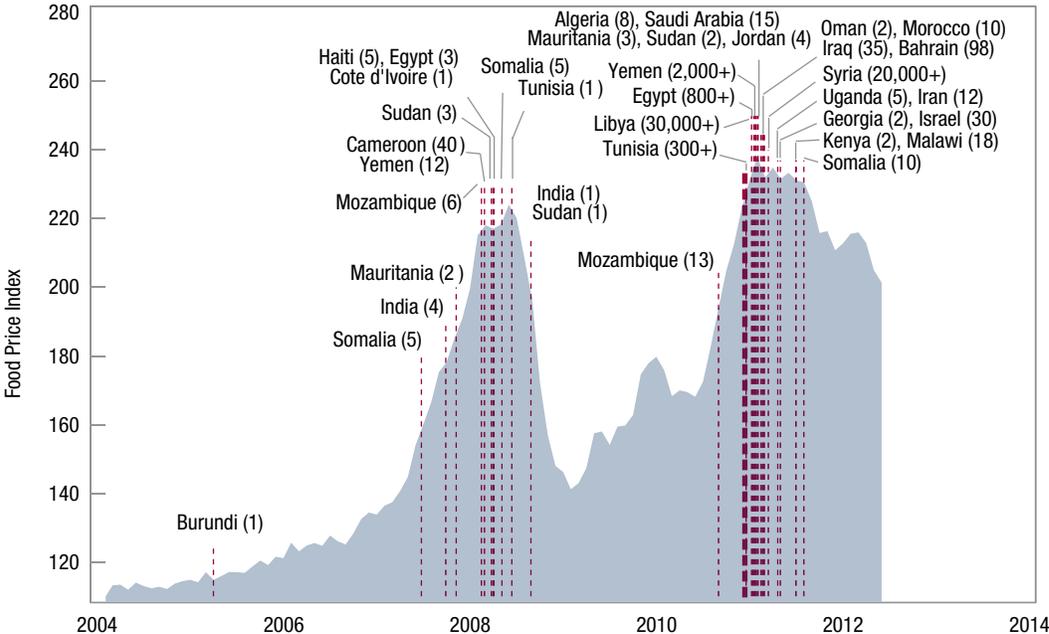
National security is enhanced

Our war-weary nation has a strong interest in preventing the sorts of conflicts that open the way for civil wars or turn weakened states into sanctuaries for terror groups that pledge harm to the United States and its allies. In Sub-Saharan Africa, agriculture is so crucial for stability that drought and high food-prices are a leading indicator for civil conflict (see figure 6).⁸²

Hunger, social instability, and war are bound together. In the developing world, war often causes hunger, and hunger itself can make people angry and desperate enough to take to the streets or take up arms. When events spiral out of control, US intervention in the form of emergency food assistance—or even more costly military engagement—becomes more likely. It costs far less to help countries improve their productivity and economic growth than to send in US armed forces in response to political crises. New research suggests that helping smallholder farmers in poor nations become self-sufficient is one of the most effective types of foreign aid for promoting peace. While foreign aid is often criticized for ending up in the wrong hands, agricultural development is good at reducing income inequity because it naturally flows to a large group of poor people: farmers.⁸³

The ability of agricultural development to sow peace is recognized by the US military, which assigned National Guard units to help farmers in Afghanistan with their agricultural problems.⁸⁴ “The symbol of the National Guard tells the story,” said former

Figure 6 – Correlation of food price index to social unrest, 2004 to 2012



Red dashed lines correspond to the beginning dates of “food riots” and protests in North Africa and the Middle East between 2004 and 2011. The overall death toll is indicated in parentheses next to each country.
 Source: Lagi, Bertand, Bar-Yam 2011.

Secretary of the Army Pete Geren. “The National Guard Minuteman has a musket in one hand, and his left hand is on a plough. This is the history of the Citizen-Soldier, and the history of our nation. And we’re taking that same combination of skills and applying it to needs in Afghanistan. . . . The magic of this approach is the civilian skills that you’re able to bring to bear on the economic development in Afghanistan.”⁸⁵ Or as former Secretary of Defense Robert Gates put it: “Economic development is a lot cheaper than sending soldiers.”⁸⁶

Political leaders on both sides of the aisle firmly believe defeating hunger is often the key to winning peace. President George W. Bush created the Millennium Challenge Corporation in 2002 as a tool for fighting terror. “The advance of development is a central commitment of American foreign policy,” said President Bush in his address that year at the Inter-American Development Bank. “As a nation founded on the dignity and value of every life, America’s heart breaks because of the suffering and senseless death we see in our world. We work for prosperity and opportunity because they’re right. It’s the right thing to do. We also work for prosperity and opportunity because they help defeat terror.”⁸⁷

Likewise, Secretary of State John Kerry addressed the indelible link between food security and peace when he was chairman of the US Senate Committee on Foreign Relations. “We have long viewed global hunger as one of our great, moral challenges,” he said during an April 2010 Senate hearing. “And all of us have been moved, at one point or another, by the stark images of hunger, of desperation, and particularly on the faces of the young children in many parts of the world. Food insecurity also poses a challenge to our broader development efforts, and yes, it is also a challenge to our

national security. A lack of access to food leads to malnutrition, instability, and even violence. Food riots two years ago in Cairo, Port-au-Prince, and other capitols showed how food insecurity can drive conflict. And because as much as 70 percent of the world's population is involved in agriculture activities, food security also has to be a cornerstone of our development strategy.”⁸⁸

Finally, Senator Pat Roberts, a Republican from Kansas, explained the stakes behind the race to feed humanity in his statement on the occasion of the USDA's 150th anniversary. “As the global population tops nine billion in the next several decades, agriculture production must more than double to meet the expected demand for food and nutrition. . . . The importance of agriculture's mission cannot be overstated. It is also a matter of national security. A well-fed world is a much safer and stable place than a hungry world. Full bellies lead to stability, economic growth, and peace. Hungry bellies lead to discontent, instability, and extremism.”⁸⁹

The Nobel committee recognized how agricultural science can break the bond between hunger and war when it gave the Iowa-born plant breeder Norman Borlaug the Peace Prize in 1970 for his role in the Green Revolution. In his acceptance speech after receiving the Peace Prize, Dr. Borlaug warned that gains of the Green Revolution would ebb away “if we become complacent and relax our efforts.”⁹⁰

Some 40 years later, science must rally again to the challenge of feeding the world. How to reinvent agriculture so that our fragile planet can nourish our children is a challenge worthy of our greatest political and scientific institutions.

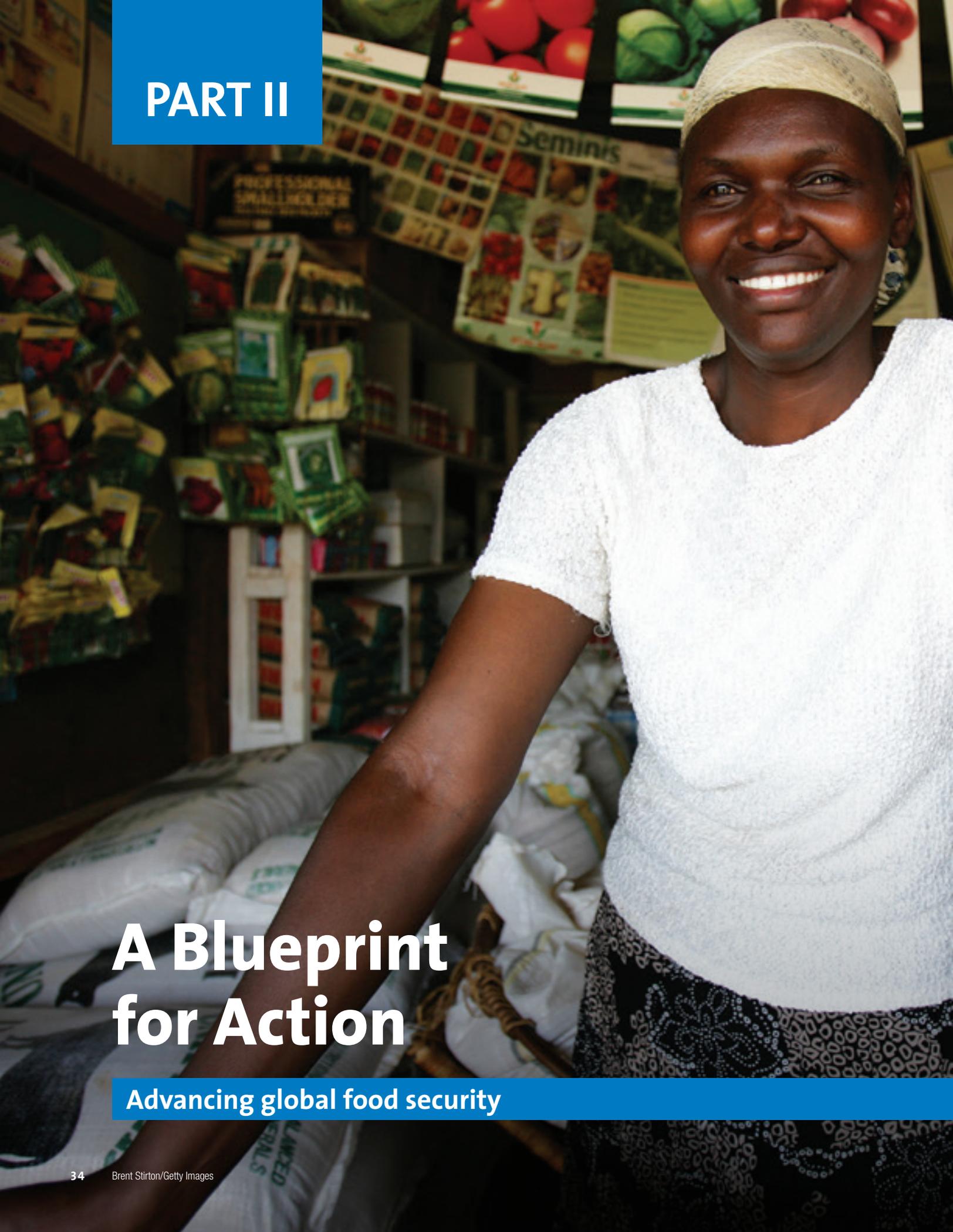


The pangs of hunger among the disadvantaged and developing nations ought to serve as a crystal-clear lesson for those who make and report public policy: food security also is irrevocably tied to international peace and national security.



Senator Chuck Grassley (R-IA), 2009





PART II

A Blueprint for Action

Advancing global food security



The United States must make global food security a priority if the world is to avoid a crisis of hunger and political instability. The United States can lead the way to a better-fed, more prosperous and peaceful world by adopting a science and trade strategy that leverages the power of business, the elements of which are offered below.

For this strategy to succeed, the US government must engage all major institutions in American life—universities, research institutes, major companies, and NGOs. While these recommendations are aimed at the US government, their successful implementation depends upon the involvement and commitment of private institutions, both nonprofit and for-profit.

It cannot be emphasized enough the need for this to be a government wide effort that involves the executive branch and its agencies as well as Congress. Unless and until the great national purpose proposed in this report is written in the books of law, a food security strategy will not have the stature and sustainability that it must have to be successful. Likewise, this strategy is so central to US interests that it deserves the attention of the vice president, who should be given responsibility for marshaling and directing the efforts of federal agencies as well as leading a new National Science Commission on Global Food Security.

RECOMMENDATION 1



Make global food security a high priority of US economic and foreign development policy

The Obama administration should be applauded for partnering with many African countries and international donors to prioritize global food security. A number of countries in Africa have led the way by committing to transform their agricultural sectors through the Maputo Declaration in 2003, helping to convince their neighbors and world powers to shed their complacency about food security. In the wake of the 2008 food crisis, the administration played an integral role in getting G8 members to increase their support for agricultural development in hungry nations at their 2009 conference in L'Aquila, Italy. Other nations are also making this commitment.

President Obama rightly made food security a goal of his administration's foreign aid strategy. He set a powerful example by promising \$3.5 billion in US government spending from 2009 to 2012 to help smallholder farmers in hungry nations around the world (see figure 7).⁹² From rice growers in Liberia to mango producers in Haiti, the administration's Feed the Future program is helping millions of farmers get training and technology.⁹³ The goal is for them to grow enough food to feed their families and to have surplus crops to sell for income to climb out of poverty.

This is a good first step. But the US government is not yet set up for the decades of work that are required. The task—ensuring that the nutritious food that the United States and other countries need is produced in a way that protects the ability of future generations to grow more food—is Herculean. The global food system is growing fragile even as it needs to become more resilient and productive in order to cope with soaring demand amid dwindling natural resources and climate change. Developing the innovations to meet these challenges is a feat that should excite a new generation of scientists and entrepreneurs.

Leadership by Congress is essential

The federal government needs to commit now to a strategy that lasts beyond one president's administration. To do this, the 113th Congress should pass legislation that creates a lasting US strategy for global food security. A potential model for this legislation is the bipartisan Lugar-Casey Global Food Security Act introduced in 2008. The legislation has languished despite approval by the Senate Foreign Relations Committee, squandering precious time.

While the Obama administration has worked hard to recruit foreign governments to the cause of global food security, the White House has not done enough to engage US legislators, even to the point of refraining from working with supportive members on crafting a bill. The administration has limited its efforts in Congress to securing the support of appropriators for specific budget requests. By not seeking the support of the Agriculture and Foreign Affairs committees, the administration is jeopardizing any chance for the formation of a sustainable food security strategy that outlasts the current presidency.

The job ahead requires a level of resources that can only be obtained through Congress and the White House working together. Money for the initiatives presented in this report will wax and wane unless Congress buys into this approach early in the process, funds it adequately, and can hold officials accountable through congressional hearings. Two of America's foreign policy successes—the Millennium Challenge Corporation (MCC) and the President's Emergency Plan for AIDS Relief (PEPFAR)—sprang out of close collaboration between Congress and the administration of George

W. Bush. PEPFAR and MCC have enjoyed continuing support from Congress since their launch.

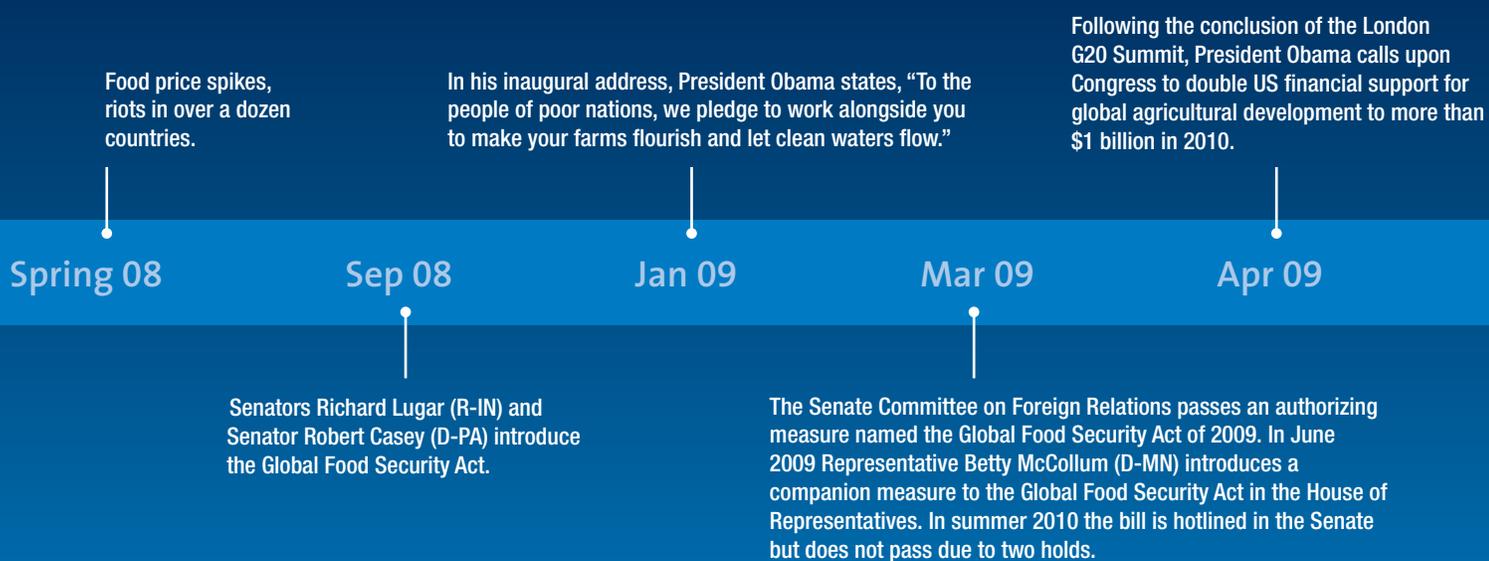
Congress has a wealth of knowledge that is essential for creating and carrying out a strategy for global food security, a task that involves many disciplines and the backing of many constituencies. Yet Congress cannot unlock these assets unless its members do a far better job of working across party lines and committee jurisdictions. In the Senate, for example, the Agriculture Committee has oversight of food aid programs, while the Foreign Relations Committee oversees all other foreign assistance, food security, and international agricultural development programs. In the House, the Foreign Affairs and Agriculture committees share jurisdiction over international food aid programs. And while the Food for Peace Act, formerly referred to as P.L. 480, and the McGovern-Dole Food for Education and Child Nutrition programs are both part of the International Affairs budget, they are not included in the State Department and Foreign Operations bill. They are instead part of the Agriculture Appropriations bill, where they compete with domestic farm subsidies and domestic nutrition programs.

A global food security strategy is affordable and bipartisan

Legislators cannot allow the budget crisis to deter them from preparing agriculture for the future. The architects of this proposal well understand that the federal debt crisis makes this a difficult time for Congress to increase spending on anything. This proposal includes several actions that can be taken without additional costs and suggestions for how to use current resources more strategically and efficiently. The consequences of inaction put America's economic and national security interests—and its ability to ensure a safe, affordable, and nutritious food supply for its citizens and others around the world—at such risk that making the modest increased investments suggested in this report now is the most financially prudent course of action.

Nor should partisan politics stand in the way of food security. Virtually every senator and many representatives have farming constituencies. The future competitiveness

Figure 7 – Timeline of US leadership in global agricultural development, 2008 to present



of US farmers hinges on their ability to innovate in order to overcome the challenges detailed in this report. Agricultural development is a proven tool for reducing hunger and creating economic growth in the developing world, which are antidotes for the political instability that can breed terrorism. Agricultural development is also necessary for making progress on many other issues before Congress such as global health, women's empowerment, and protecting the world's natural resources.

Americans are instinctually concerned about hunger, which is one reason why 74 percent of the USDA's total outlays of \$145 billion in fiscal 2012 were for nutritional assistance.⁹⁴ Congress helped create America's unique character through its long history of support for agricultural development. Congressional passage of the Homestead Act of 1862 allowed a citizen to gain title to 160 acres of public land in exchange for farming it. Homesteaders would eventually claim 270 million acres.⁹⁵ The government could have sold off this land in big chunks as a way to raise money for the treasury. But Congress had the wisdom to see the greater good that would come from encouraging the development of a class of independent farmers. Agricultural development can be just as powerful in the developing countries of today.

As policymakers take up the task of global food security, they should reorganize the government's effort so that all the appropriate resources are brought to bear. While the Obama administration's Feed the Future initiative has shown great promise in a short time, it does not command the full range of actors and expertise necessary to meet future challenges. For example, US food aid programs are not considered part of the Feed the Future initiative. Likewise, promoting agricultural trade is not yet a high enough priority of US trade negotiators. Nor are public investments in science fully integrated in ways necessary to overcome challenges of a global nature.

President Obama pledges to commit \$3.5 billion over three years to global hunger and food security initiatives to address hunger and poverty. This is part of a broader global pledge of more than \$20 billion announced at the 2009 G8 meeting. In addition to these pledges, G8 leaders put forward new principles for sustainable food security, which are later endorsed at the 2009 World Summit on Food Security in Rome. The pledges and principles are referred to as the L'Aquila Food Security Initiative.

Jun 09

Secretary of State Hillary Clinton announces the seven guiding principles of the US Global Hunger and Food Security Initiative.

Jul 09

The Global Agriculture and Food Security Program is established through the World Bank to assist in the implementation of pledges made by the G20; the United States pledges \$475 million to the fund.

Sep 09

Secretary Clinton announces the release of the Global Hunger and Food Security consulting document and launches the search for the Global Hunger and Food Security Initiative coordinator.

Action 1A—Congress should commit the nation to a global food and nutrition security strategy

Congress is essential for the success of this effort, which hinges on the entire US government working together. Most importantly, Congress should pass authorizing legislation that commits the government to provide resources for a long-term strategy for global food security. The president should actively support this effort. As mentioned earlier, the Lugar-Casey Global Food Security Act is an example of the type of authorizing legislation that is needed to galvanize the US government. Sustaining food security as a top government priority depends on congressional endorsement. PEPFAR, for example, has been a success in part because of the ongoing support of Congress.

Each chamber should hold at least one hearing per year to determine whether the government is making sufficient progress on global food security and take corrective action if progress is lagging. Hearings should involve the House Agriculture Committee and the Senate Agriculture, Nutrition, and Forestry Committee; the House Foreign Affairs Committee and the Senate Foreign Relations Committee; the House Science, Space, and Technology Committee and the Senate Commerce, Science, and Transportation Committee. These joint hearings are opportunities to bring the expertise of several committees together around a challenge that cuts across jurisdictions to build support among various interest groups.

There are many other ways in which Congress can partner with the executive branch. Further action items for Congress are included with the recommendations that follow.

Action 1B—The vice president should oversee the US government’s global food and nutrition security strategy

The global food security strategy is so essential to the economic well-being and defense of the United States that high-level leadership is required to elevate its importance across the entire government. The president should assign the vice president the task

Figure 7 – Timeline of US leadership in global agricultural development, 2008 to present, cont.



of overseeing this governmentwide agenda to ensure the United States can fully exploit the expertise of all agencies. In this role, the vice president will be able to set goals, plan strategy, and direct federal resources. The vice president should be assisted by a global food security counselor in the National Security Council.

While USAID should retain leadership of the Feed the Future initiative, it lacks sufficient authority to direct and coordinate the activities of other agencies that are vital to this effort. The vice president has that authority. Putting the vice president in charge of global food security would elevate the issue within the US government and ensure that federal agencies are working together in a timely fashion on such things as recommendations from the National Science Commission on Global Food Security (see recommendation 2).

USAID, as the lead development agency, should continue to be strengthened and take advantage of the expertise of other agencies. The USDA has expertise in many of the areas crucial to the food security effort such as agricultural research, soil, nutrition, forest, water conservation, rural development, and regulation of biotechnology. The USDA and Food and Drug Administration (FDA) help to ensure the safety of our food supply and should assist developing countries in creating similar safety programs. USDA could be particularly effective in increasing some of its existing work with agriculture ministries to develop the regulatory framework necessary to protect against food contamination and the spread of animal and plant diseases. Given the global nature of the travel industry and the food system, highly contagious agricultural diseases such as swine flu and the foot-and-mouth disease virus in livestock can cross borders very quickly. It is in our national interest to help other countries develop the ability to detect disease outbreaks quickly enough to limit their spread.

USAID should tap into this expertise to support farming best practices that guard against the outbreak of food-related illnesses. Equally, the Office of the US Trade Representative and the Department of Commerce could help identify bottlenecks to trade and business development. The Peace Corps, which has about 320 volunteers

The Consolidated Appropriations Act H.R. 2055 (often called the FY12 Megabus) relaxes the terms of the Bumpers Amendment, which previously had prohibited the United States from supporting agricultural development for commodities that could compete with US farmers.

Dec 11

The Surface Transportation Bill, Ocean Freight Differential, reduces the cargo preference requirement for US food aid from 75 to 50 percent.

Jul 12

May 12

President Obama announces the G8 New Alliance for Food Security and Nutrition, which includes a commitment to sustain US financial commitments to global agricultural development and a public-private partnership model supported by \$3 billion in commitments from businesses and NGOs.

The FY14 Presidential Budget Request recommends food assistance reform, including transitioning the United States to a cash-based food aid system and ending monetization.

Apr 13



Technoserve

“ *And the Feed the Future Program—which is modeled on the Global Food Security Act I sponsored with Senators Lugar and Casey—has been undertaken by the Obama administration. The program works to break the cycle of hunger and food insecurity by getting at the root causes and helping countries develop their own viable agriculture sectors.* ”

Senator Dick Durbin (D-IL), 2011

working on agricultural projects, could expand their extension work, as could the Americans who participate in the John Ogonowski and Doug Bereuter Farmer-to-Farmer Program.⁹⁶

Action 1C—Sustain global food and nutrition security funding and increase resources for scientific collaboration and capacity building

International programs designed to tackle global agricultural development and food security need a sustained commitment over the long term. This requires investments in both research capacity and agricultural development activities. Funding for Feed the Future and nutrition should be increased to an average of \$1.5 billion annually over the next 10 years from its current level of roughly \$1.1 billion. This would allow for the program to continue its work in the present 19 focus countries and to direct sufficient resources toward building up scientific capacity in select countries (see recommendation 2).

Global agricultural productivity has slowed during the same period in which public investments in research and technology development have been flat.⁹⁷ Yet farm productivity is continuing to climb in countries where the government puts a high value on public agricultural research.⁹⁸ The reality is that developing countries typically do not have the capacity, either at their universities or research centers, to fully collaborate with existing international research systems.

Equally, the US government needs to expand funding for agricultural development assistance programs, which benefit both US and global agriculture (see figure 8). It must also strengthen US government agencies that manage aspects of agriculture, food security, and foreign assistance. US programs to facilitate trade, improve business and regulatory environments, build better networks of international research collaboration, and improve dissemination of technology will require up-front investments. As discussed earlier, these investments reap big returns for the United States in the form of economic and business opportunities and a safer, more politically stable and prosperous world.

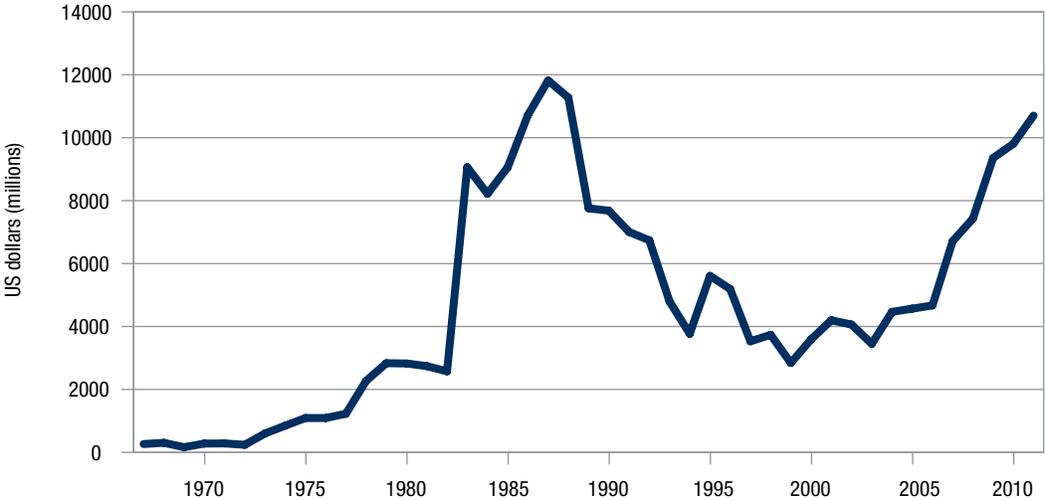
As presented in recommendation 2, there must be sustained funding of research on the home front so that agricultural science can broaden its mission.

COST: \$386 million annually (see action 2D and 2E for details)

Action 1D—The United States should urge the international community to prioritize food and nutrition security goals in the post-2015 development agenda

As the international community considers the post-2015 development agenda, it is worth noting that a number of countries will reach or are approaching the Millennium Development Goal 1 target of reducing poverty and hunger by half.⁹⁹ Unfortunately, the target remains an elusive quest for many. There is value in goal setting. It creates a mission to work toward and a clear way to measure progress. The United States should encourage continued progress towards existing Millennium Development Goals and consider recommending new goals related to food security for the post-2015 global development agenda.

Figure 8 – US official development assistance (ODA): Agriculture, forestry, fishing, 1967 to 2011



Source: OECD Statistics 2013.

RECOMMENDATION 2

Forge a new science
of agriculture based
on sustainable
intensification

Science faced an earlier food crisis and triumphed. Armed with big increases in public spending on agricultural research and development, scientists in the 1960s and 1970s launched the Green Revolution by delivering to farmers in Asia and Latin America improved varieties of wheat and rice. These two crops thrived with the intensive use of irrigation, inorganic fertilizer, pesticides, and mechanization. Grain production accelerated so much more than the population rate that the threat of a massive famine faded away.

Agricultural science is needed once again to deliver innovations that can prevent the global food system from being overwhelmed. But the innovations that farmers require are so different from the past that agricultural science must reinvent itself in order to get the job done.

During the Green Revolution, scientists were focused on fighting famine and did not fully understand how their production methods depleted and contaminated waterways, sped soil erosion, diminished biodiversity, and would make farmers more vulnerable to the price of fossil fuel.

Nutritious food must be produced in a sustainable way

Society can no longer afford to increase food production this way. Farmers in the United States and abroad face a future in which natural resources such as water and arable land grow ever scarcer as climate change and weather variability upsets farming ecosystems. As a result, science must now focus on the sustainable intensification of agriculture. At a minimum, this means giving farmers the technology and techniques to make more food with less energy and less inputs such as water, fertilizer, pesticides, and even land, while strengthening their ability to adapt and bounce back from shocks such as new pests and new weather patterns.

Agriculture is far more than a machine for producing calories. It is a livelihood and culture as well as a tool for improving health, sowing peace, empowering women, fueling economic growth at home and abroad, and protecting our environment through solutions such as drawing atmospheric carbon into the ground. Agriculture is also the most effective way to fight poverty in many of the poorest parts of the world. Research shows that 1 percent growth in the agricultural economy fuels a 6 percent increase in spending by the poorest 10 percent of populations. Far less income filters down to the poor from the growth of other parts of the economy.¹⁰⁰

The innovations that will be needed range from weather-monitoring irrigation equipment and precision climate forecasting to new seeds for plants that tolerate heat, drought, and disease and are endowed with genes for producing micronutrients such as vitamin A.

Unlike the Green Revolution era, scientists will need to tailor a wide assortment of technologies and techniques for the smallholder farmers they aim to help. Closing the productivity gap in the developing world is not as simple as introducing high-input, high-tech farming methods to growers. Much of Sub-Saharan Africa's soil is too degraded for high-scale crop production, for example. Many farmers there would gain the most from first adopting low-input, low-cost techniques that improve the natural fertility of their soil. Likewise, improved varieties of open-pollinated crops might be more practical for some smallholder farmers in the immediate future than higher-yielding hybrid varieties that pull more nutrients out of the ground. In short, scientists

should have the means and the freedom to make available to smallholder farmers all sorts of agricultural technology—from low-input to high-tech options. A big part of their job is matching farmers to the appropriate technology.

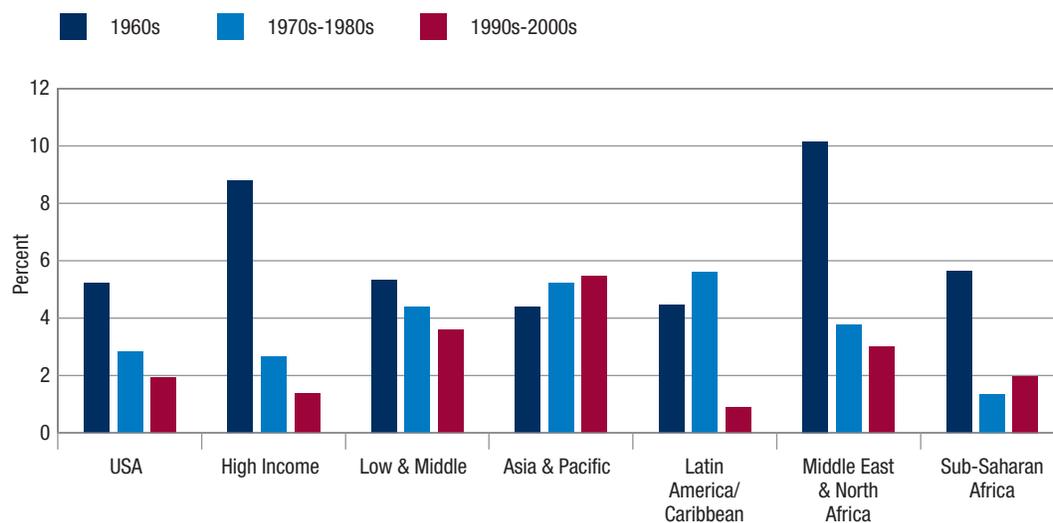
Agricultural science must be rejuvenated with a focus on sustainable intensification

The competitiveness of the US agriculture sector also hinges on its ability to find ways to farm more sustainably. Water tables are falling across the Great Plains.¹⁰¹ Precious topsoil continues to flow down the Mississippi River to the Gulf of Mexico.¹⁰² US farm yield measured by total output is slowing.¹⁰³

The US agricultural science system needs to be better equipped to take on this new mission of sustainable intensification. Publicly funded research is vital to the advancement of agriculture because private companies are unwilling to invest in the basic research that benefits society but is hard to capitalize upon quickly. Unfortunately, public spending on agricultural research has grown so little over the past 30 years that US scientists have had little opportunity to embrace any new mindset, and their field has grown isolated.¹⁰⁴ The President’s Council of Advisors on Science and Technology observed:

“One of the drawbacks of the current system of agricultural research is that there is often a separation of agricultural research from other areas of biology, chemistry, social sciences, earth sciences, computer sciences, and engineering. . . . At times, this apparent fragmentation between agricultural research and sustained interaction with other basic sciences at the univer-

Figure 9 – Rates of growth in public agricultural R&D spending, 1960 to 2012



Note: Eastern European & former Soviet Union countries are excluded. All growth rates were calculated using the least-squares method (i.e., as the slope of a regression of logarithms of variables against trend). Asia & Pacific includes China and India; Latin America & Caribbean includes Brazil. High-income countries are excluded from each geographical region. For example, Asia & Pacific excludes Japan and Singapore; Middle East & North Africa excludes Qatar and United Arab Emirates. The 1960s indicates the period covering 1960 to 1970 and likewise for other decades.

Source: Pardey and Beddow 2013.



Bill & Melinda Gates Foundation/Prashant Panjari

“ Production agriculture’s current economic strength is a direct result of research that—among other things—has increased crop yields, made livestock healthier, and made food safer. ”

Senator John Thune (R-SD), 2011

sity level can prevent or delay the transfer of knowledge and discovery, ultimately delaying the agricultural gains that are needed.”¹⁰⁵

China and India, meanwhile, have nearly tripled their investment in public agriculture research over the past 20 years (see figure 9).¹⁰⁶

Given the complexity and enormity of the challenge, the US government should prepare agriculture for the future by adopting a science strategy for global food security. As a part of this strategy, the government should greatly increase its funding of agricultural research and direct those investments so that agricultural science embraces the broad array of disciplines needed to meet the food security challenge. This includes bringing expertise and approaches from other fields to bear on agricultural production.

Sustainable intensification is the key

Sustainable intensification means increasing outputs—production, nutrition, and incomes—using the same amount or less of land and water through efficient and prudent use of inputs, while adapting to climate change and reducing agriculture’s impact on the environment.¹⁰⁷ It builds resilience and efficiencies into all phases of the global agricultural system so that it can adapt to the effects of climate change and rebound from weather variability that disrupts farming and food distribution. Sustainable intensification also puts a priority on health by improving the nutritional quality of food. And for research to be productive, the innovations that result must be widely available and accessible to those who wish to adopt them. The tools to sustainably intensify agri-

Box 8 – The impact of innovation on smallholder farmers—a success story

Philip Ngolania considered it a miracle that he was surrounded by stalks of maize. The rains had been meager even by the semiarid standards of the Machakos region south of Nairobi. During the growing season there had been just three short periods of rain with weeks of drought in between. His stalks were thin and rather anemic-looking, yet they still produced uniformly large ears of corn. At planting time Philip had sown a new variety of seeds that promised to be more tolerant of drought conditions.

His neighbor did not trust the new seeds. He had used the traditional, local maize called *mbembasitu*, which means “our own maize seed.” His maize was shriveled and dead, the stalks having toppled in their feebleness. There wasn’t a cob to be found.

“My neighbors, they asked me for my secret, why I have cobs, and they have none,” Philip said. “I tell them, ‘It is the variety I use.’ I’m telling them they must change from the *mbembasitu* to the new variety.”

The new variety had been developed by the Drought Tolerant Maize for Africa program, which was launched in 2006 with initial funding from the Bill & Melinda Gates and the Howard G. Buf-

fett foundations, USAID, and the UK Department for International Development. The program was implemented by the International Maize and Wheat Improvement Center and the International Institute of Tropical Agriculture. The goal was for national agricultural research institutes to develop drought-tolerant maize varieties and get them into the hands of 30 to 40 million smallholder farmers on the continent.

Philip had purchased the seed from Dryland Seed, a private company that was multiplying the drought-tolerant variety developed by Kenyan breeders. He bought four kilograms, paying a total of 540 shillings (about \$6). His neighbor, who used the *mbembasitu* seeds saved from the previous harvest, paid nothing. Philip reckoned he had made the better investment. He estimated that he would harvest about four 90-kilogram bags of maize. His neighbor would have to purchase maize, the country’s staple food, on the market for more than 3,000 shillings per bag.

Farmers should adapt to newer technology, Philip said, because “the climate is changing very fast. Ever since I was born, I haven’t witnessed drought seasons like this.” That would be since 1942.

Source: Thurow 2012.



culture differ depending on where agriculture is being carried out, but the principles are the same.

A science strategy for food security would put sustainable intensification at its core by tapping into disciplines such as health and nutrition, ecology, hydrology, life sciences, information technology, and the social sciences to name just a few. New innovations can help farmers avoid many of the unintended environmental consequences caused by the Green Revolution. Fertilizer and pesticide application is becoming far more precise, for example, and farmers are learning how to plant and harvest in ways that barely disturb the soil, greatly reducing erosion while protecting the natural fertility of the land.

Growth in productivity will remain vitally important. Without significant improvements in production, food demand by 2050 will threaten to undermine global economic growth and political stability. But it is not just about producing more food staples or even increasing the caloric content of what people eat. Scientists need to incorporate nutritional value and crop variety, even while they pursue greater productivity. This will require sustained attention. Given the long lead time for new research to be applied in the field—from 10 to 30 years—any diversion of resources and commitment could disrupt potential gains.¹⁰⁸

As a part of this science strategy, the United States should rally other nations and increase its engagement with traditional and emerging donors to help develop the innovations that are needed by farmers in the developing world. The United States has begun to work with emerging donors and G20 nations such as South Africa, Brazil, and India through trilateral cooperation programs.¹⁰⁹ This approach has many benefits, leveraging additional funding and specific expertise and focusing emerging donor programs on an issue of global importance. By aligning resources and expertise, cooperative programs will have greater reach and impact with greater cost-effectiveness than any individual country's programs. Similarly, the United States should encourage a division of labor among traditional donors, as called for in the President's Policy Directive on Global Development.¹¹⁰

The goal should be to shrink the productivity gap in the developing world so that an acre of land there produces as much as in the developed world, all while using fewer resources. Much of the basic research that needs to be done to help US farmers would have implications for farmers in Africa as well. What's more, agricultural science could make a huge difference in Sub-Saharan Africa precisely because so little scientific knowledge and technology has been applied. Many subsistence growers still practice slash-and-burn farming the way their ancestors did. This is degrading the quality of their soil.

Sustainable intensification includes six essential elements

Increasing production of nutritious foods, bringing higher incomes to smallholder farmers

The power of agricultural science to increase productivity and reduce poverty is well documented and, as highlighted in this report, is inextricably linked to investments in research. Productivity growth is critically important to meet the 2050 challenge. Without

significant improvements in production, food demand by 2050 will threaten to undermine the global economy.

The Montpellier Panel reported:

“Distribution and access to healthy foods as well as reducing waste and inequalities in the system are critical. But for the 80 percent of the chronically hungry who are smallholder farmers, increasing their access to food must involve generating greater yields and increased incomes from their land. Moreover, while large farms will play an increasing role, these smallholders will have to be the primary source of food for growing urban populations for years to come.”¹¹¹

A reenergized approach to agricultural research should focus on increasing sustainable production of food crops, especially those that can be grown by smallholder farmers in Africa and Asia, where agriculture is underproducing (see box 8).

Conserve land and water with efficient and prudent use of inputs

For agriculture to be more resilient, farmers everywhere will have to be better stewards of natural resources. This means sustainably using water, fertilizers, and pesticides while monitoring and reducing the emissions of nitrous oxide and methane.

While the Asian-style Green Revolution and its input-intensive practices failed to take root in Africa, a strategy of sustainable intensification could prove a far better approach. For farmers who cannot afford to buy synthetic fertilizer, which costs far more in Africa than in the United States, learning about inexpensive soil management techniques that improve fertility through increased organic matter makes sense.

A key element of sustainable intensification is to help farmers do a better job of harvesting water such as by reducing runoff from rain-fed fields and by increasing the efficiency of irrigation systems. While water is a somewhat renewable resource, it is finite, and agriculture has a huge impact on downstream users. Producing enough calories to supply the daily nutritional needs of one active adult requires thousands of liters of water.¹¹² According to the UN, 40 percent of the world’s population already copes with scarce water supplies, a figure that is expected to climb to two-thirds of the world’s population by 2025 (see box 9).¹¹³

Improve human health through accessible food that is nutritious

A narrow focus by agricultural science is undermining its ability to improve human health. Many highly nutritious crops are being largely ignored because they are not one of the major agricultural commodities. Quinoa is an example of an indigenous crop that until recently was little known outside the Andes of Latin America. It generated little in the way of research funding even as it proved to be a highly nutritious source of protein for the poor segments of society that relied on it. Its sudden popularity in the United States and Europe is pushing quinoa prices higher—a boon for its growers. But the grain is becoming too expensive for the Bolivians who consumed it first.¹¹⁴

Research on these so-called orphan crops and fruits and vegetables requires public support since their sales are too small to be of interest to private companies (see box 10). At the same time, more research is needed on how to improve the nutritional qualities of the staple crops through fortification and biofortification (see box 18). Giving a

Box 9 – Drought devastates farmers around the world— from the American Midwest to the Horn of Africa

The failure of secondary rains in October through December of 2010 throughout the Horn of Africa kicked off a devastating drought that would claim the lives of between 50,000 and 100,000 people in Somalia, Ethiopia, and Kenya. When the primary rainy season from March to May of 2011 also underdelivered, crop failure and poor livestock conditions led to cereal price spikes and slashed livestock prices and wages—a deadly combination that significantly reduced household purchasing power across the region. In August of 2011 local cereal prices in some parts of southern Somalia were more than double or triple 2010 prices. The UN estimated that adverse effects of the drought on livelihoods and local markets touched 13 million people throughout East Africa in 2011, and USAID data reveals that more than 29,000 children in the region under the age of five lost their lives from May to June alone.

As crisis abated in the Horn of Africa, the 2012 growing season in the United States demonstrated the indiscriminate nature of drought-triggered destruction, as the most extensive drought since

the 1950s devastated the American Midwest. A promising early season with favorable conditions gave way to a hot, dry spring and summer that crippled soybean and especially corn yields. The US corn harvest in 2012 is estimated at 10.8 billion bushels, the smallest in six years. Looking toward the upcoming growing season, some farmers in top US grain-producing states are reportedly planning to shift acreage away from corn to other crops—particularly soybeans, which are less reliant on summertime rains—to avoid another season of devastating losses. However, a retreat from corn production in states such as Illinois and Iowa, whose fields typically produce over one-third of the nation's corn crop, could drive up world food prices as US corn stockpiles drop to a predicted 17-year low this summer.

As variable weather patterns continue to upset growing cycles and disrupt agricultural production worldwide, it becomes more imperative than ever to harness the power of science and technology to seek innovative solutions.

Sources: Oxfam 2012; DFID 2011; FSNAU and FEWS 2011; Slim 2012; USDA ERS 2013; USDA WAOB 2013; USDA ERS 2013; Polansek 2013.

Box 10 – Investing in orphan crops balances nutrition, environment, and development goals

In recent decades, investments in genomics and molecular breeding have focused on the world's major food staples such as maize, wheat, and rice, substantially enriching our understanding of how to increase these crops' productivity and resilience. However, many key crops grown in developing countries have attracted far less scientific attention despite their cultural and economic importance, nutritional impact, and environmental adaptability. Cassava is the most widely produced crop in Benin, Ghana, Malawi, Nigeria, and Uganda, and Sub-Saharan Africans plant almost five times as many hectares of sorghum and millet each season as they do rice and wheat. Roots and tubers such as sweet potatoes, cassava, and taro provide Sub-Saharan Africans with more than 400kcal of energy per person each day, while Ethiopians, on average, glean 240kcal of energy per person each day from tef alone. These commodities and others such as cacao, cowpea, and groundnuts are known as orphan crops due to their comparative absence from the international research agenda. Yet throughout the developing world, they are widely produced, represent key dietary staples, and thrive in hot, dry, and otherwise harsh growing environments. Orphan crops are locally critical, but they attract meager research and development funds

due to their geographic specificity and their failure to incentivize private investment.

The African Orphan Crops consortium has convened the New Partnership for Africa's Development; the Gates Foundation; IBM, Mars Inc.; the University of California, Davis; and other partners to address this challenge. In 2011 the group unveiled a \$40 million plan to work with African scientists to identify and sequence the genomes of 24 underresearched crop species native to Sub-Saharan Africa. Key to the new initiative will be the African Plant Breeding Academy, established by UC Davis in Accra, Ghana, where the consortium plans to train 250 African scientists and 500 African technicians in modern plant-breeding techniques such as genome sequencing, bioinformatics, and phenotyping. This first cohort of African plant breeders will then further extend and sustain breeding programs, thus training a new generation of African scientists to address challenges facing African crops.

Molecular breeding is an essential component of crop improvement in the developed world. To adequately increase agricultural production and advance food security worldwide, it will be essential to apply the same technology to the orphan crops of the developing world.

Sources: University of California, Davis 2011; University of California, Davis 2013; Naylor et al. 2004; Vanderschuren 2012; Mars 2011.

cereal crop such as corn or rice the ability to make vitamins and minerals is a very efficient way to improve the diets of the poor, who tend to rely on these crops for most of their nutrition.

Adapt to climate change

Agricultural science also needs to begin preparing farmers to adapt to climate change. The places where many crops thrive now will shift as temperatures rise. So, too, will the ranges and virulence of many pests and plant diseases. Replacement crops or seed improvements will be critical to keeping existing farmland in production.

The effects of climate change are projected to create hardships for the most vulnerable, especially in arid and semiarid regions and the megadeltas of Sub-Saharan Africa and South Asia (see box 11).¹¹⁵ Climate change will also affect the quality and quantity of water resources. Currently, 780 million people lack access to clean drinking water, and 2.5 billion do not have sanitation.¹¹⁶ Population growth will increase competition for water between agriculture and other uses as farmers seek to increase their production.

Reduce environmental impact

While agriculture is susceptible to climate change, it also affects the environment. When done right, agriculture can improve the environment at all points in the food value chain by building up natural enemies of pests, increase pollinators, sequester carbon, and build up the natural resource base in other ways.

The effort to raise agricultural productivity globally in response to growing demand does not have to mean a greater impact on the environment. For example, currently only 4 percent of arable land in Africa is irrigated, far below levels in other regions. The push to raise productivity there poses potential consequences for water resources.¹¹⁷ The agriculture and food sectors can balance the demand for increased productivity with efforts to preserve soil nutrients, minimize deforestation, and reduce stress on water resources. These sectors can also utilize approaches and innovations that will improve sustainability and the natural resource base at all points in the value chain—from the farm to retailers. We must educate and incentivize those working in agriculture and food everywhere to employ farming practices that consider local environmental and hydrological factors. Farmers both large and small—and others involved in agriculture and food—will need access to proven and new approaches and innovations that mitigate environmental impact. Research will need to focus on both aspects—how climate change affects productivity and activities across the value chain and how agriculture can meet demands in a sustainable manner.

Reduce food waste along the supply chain

Worldwide, 35 to 40 percent of food is wasted. In the developed world, it is thrown away from supermarket shelves, refrigerators, or at restaurants. In the developing world, crops rot before they can be brought to market because of insufficient storage.¹¹⁸ Africa currently loses enough grain to feed 48 million people for a year because of problems relating to harvesting methods, handling and drying techniques, type or availability of storage, contamination, pests, and pathogens.¹¹⁹ Conservative estimates by the African Postharvest Losses Information System put grain losses in eastern and southern Africa at \$1.6 billion annually, or about 13.5 percent of the total value of the grain harvests.¹²⁰

Box 11 – Submergence-tolerant rice helps farmers battle flooding

Widespread flooding in Pakistan in recent years has profoundly affected the country's agricultural sector and called attention to the effects of weather variability on agricultural production worldwide. In 2010 devastating floods in Pakistan brought major losses for the country's sugarcane, rice, cotton, and maize crops. The disaster affected 5.2 million acres of cropland, with a corresponding price tag of over \$5 billion in damages to the agricultural sector. Flooding presents a challenge to farmers beyond Pakistan, even in areas known to be flood prone, due to the variable and unpredictable nature of floods—submergence might occur chronically, once every few years, or even less frequently. Rice production is particularly threatened—35 percent of the total rice area in Asia, which produces over 90 percent of the world's rice, is rain fed and flood prone. Submergence regularly affects over 20 million hectares of rice in the tropics in Africa as well as Asia, and while more tolerant rice varieties can survive submerged for two weeks or more, other varieties are substantially damaged or killed after one week under water. Predictions of rising sea levels and increased flood frequency and intensity, especially because most rice production areas in South, East, and Southeast Asia are low-lying, exacerbate the challenge.

Concentrated efforts to identify submergence-tolerant rice varieties began in the 1970s, and advancement progressed with the advent of molecular mapping using DNA markers in the 1990s. Using DNA markers, scientists identified the key determinant gene of submergence tolerance, designated as Sub1. Backcrossing began in 2003 to create eight Sub1 versions of Asia's most widely planted rice varieties, marrying the high yields and strong grain quality of these preferred mega-varieties with the submergence tolerance afforded by the Sub1 gene. The results were promising—the Sub1 varieties performed nearly iden-

tically to the mega-varieties in growth, yield, and grain quality when tested in shallow areas without submergence, and when grown in complete submergence, Sub1 varieties survived at a significantly higher rate and recovered significantly faster than their mega-variety counterparts. On average, the Sub1 varieties enjoyed a yield advantage ranging from 1 to over 3.5 t/ha, depending on the duration of submergence and the conditions of the floodwater. Recent research has even demonstrated that part of the Sub1 gene may help rice survive drought as well as submergence.

So far, five Sub1 varieties have been officially cleared for distribution and the remaining three are undergoing evaluation. Projects led by the International Rice Research Institute (IRRI) and funded by partners like the Japanese Ministry of Foreign Affairs and the Bill and Melinda Gates Foundation have focused on Sub1 dissemination in Bangladesh, Cambodia, India, Indonesia, Laos, Myanmar, Nepal, the Philippines, Thailand, and Vietnam. These efforts compliment many national-level extension initiatives. Because the modified varieties have the same genetic structuring as mega-varieties and hold such promise for mitigating flood effects, national and state governments have rapidly adjusted their policies to promote Sub1 dissemination. With government encouragement, production and distribution programs reached more than 1,000,000 farmers with these Sub1 varieties by 2011. Production using Sub1 varieties is targeted to approach 5 million hectares in South Asia alone by 2014, and the IRRI Stress-Tolerant Rice for Poor Farmers in Africa and South Asia (STRASA) project plans to reach 20 million farmers throughout South Asia and Africa with improved rice by 2017. Scientists hope to build on these rice improvement successes with future advances in disease resistance and salinity tolerance in rice varieties.

Sources: US Department of State 2011; Mackill et al. 2012; University of California, Riverside 2011; Bates, Kundzewicz, and Palutikof 2008.



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Meeting the challenges of global development is a critical national security and economic imperative, and applying innovative science and technology solutions to complex challenges can help keep Americans safe while also driving our innovation economy. In our current budget environment, [President Obama's call to use science, technology, and innovation to promote global development] will help ensure we make the most of every dollar by partnering with the private sector and creating cost-effective programs that work in rapidly changing the world.

”

Senator Chris Coons (D-DE), 2012

Much of the advocacy around food security calls for increasing farm productivity. But reducing postharvest loss is a cost-effective and efficient way to increase the availability of food without having to increase the amount of land farmed and place associated stresses on the environment.

Scientists can help reduce postharvest losses with a wider focus on all the points along the value chain in which losses occur, from farm to processors to consumers. Research on pest and plant disease is an integral part, in addition to the dissemination of better farm techniques. And, practical storage solutions will go a long way in helping farmers protect their harvests (see box 12).

Approaches that complement private-sector research and adoption by farmers must be implemented

Just as there must be collaboration among disciplines, so too must there be better coordination between public and private research. Private research cannot replace public work because the results of privately funded research are often kept private as compa-

Box 12 – Decreasing postharvest loss through innovation and technology

To achieve the goal of feeding more people with fewer resources, we need to think not just about boosting production, but also about reducing inefficiency. A considerable share of food grown in the developing world is lost after harvest due to technical causes like harvesting methods, handling and drying techniques, type or availability of storage, contamination, pests, and pathogens. Such loss not only wastes valuable inputs like fertilizer, water, and human labor, but also reduces the market food supply, thus elevating food prices and contributing to food insecurity and hunger. Conservative estimates by the African Postharvest Losses Information System value postharvest grain losses in eastern and southern Africa alone at \$1.6 billion per year, amounting to 13.5 percent of the total grain production value in the region. Assuming comparable magnitudes of loss continentwide, postharvest grain losses could approach \$4 billion each year in Sub-Saharan Africa. This annual figure exceeds the value of total food aid Sub-Saharan Africa received in the last 10 years, roughly equates the region's annual value of cereal imports, and translates into enough calories to feed 48 million people for one year. Low adoption rates of postharvest loss technology in Sub-Saharan Africa have exacerbated the problem—investments have too often provided short-term solutions, proven financially unsustainable, lacked economic incentive, and ignored cultural constraints.

With these past oversights in mind, Compatible Technology International (CTI) is harnessing the power of innovation and technology to address the issue of postharvest loss on a sustainable, long-term basis. The NGO creates practical tools to help communities in the developing world address their food and water challenges. In Senegal CTI worked with pearl millet farmers (many female) to develop hand-operated grain processing devices that allow farmers to capture 90 percent of the grain and produce edible grain 10 times faster than with traditional mortar-and-pestle methods. Further east, near Iringa, Tanzania, CTI is collaborating with maize farmers to evaluate better storage options during bountiful harvests and to improve drying and shelling methods. Half a world away in Haiti, CTI is combating breadfruit's short shelf life with manually operated tools that transform the carbohydrate-loaded and high-yielding fruit into gluten-free flour. The breadfruit shredder, dryer, and grinder underwent thorough functionality testing in the fall of 2012, and CTI plans to use the resulting data to help Haitian community groups develop economically sound business models. Each of these endeavors prioritizes community input, economic feasibility, cultural sensitivity, nutritional promotion, and female empowerment. CTI's innovative work reveals the capacity of smart, simple technology to address agriculture's major challenges.

Sources: World Bank 2011; Compatible Technology International 2013.

nies that paid for the research seek to recoup their costs. Still, there is a lot of wasteful overlap between them.

Invention is not enough. Scientific achievements will matter little unless the fruits of research are made available to the world's farmers in ways that can be adapted, especially by smallholder farmers. There is ample room for huge productivity gains given that African farmers still till 65 percent of cropland by hand and 25 percent with animal power; less than 10 percent is worked with a tractor.¹²¹ They are using seeds developed decades ago because they lack access to improved varieties.¹²²

A science strategy for food security must include a deep understanding of how technology is disseminated and how new approaches are adopted. Understanding the scientific endeavor as a knowledge value chain highlights the need for an integrated, multidisciplinary approach that incorporates a full spectrum of natural sciences working with the social sciences to find practical solutions for smallholder farmers in the developing world. Some of the simplest of technologies—such as the treadle pump—can raise farm yields for smallholders with minimal investment and maintenance costs.¹²³ But high-tech solutions do work in some cases. Many African farmers are already using smart phones because that technology slashes their cost of banking and crop insurance and can deliver vital market and weather information.¹²⁴ Clearly, the needs and demands of smallholder farmers must drive the selection of innovations.

How to disseminate innovations to smallholder farmers is a tough question. The publicly supported agriculture extension service in the United States might not be the best model for developing countries. New actors and new methods are already changing how farmers access data. Entrepreneurs, innovators, businesses, academics, NGOs, and others are increasingly developing, testing, and scaling up ideas and cost-saving solutions. Their engagement needs to be further incentivized. Extension services that span private business, farmer organizations, cooperatives, and NGOs in the developing world will be critical to disseminating technologies. Reaching farmers, especially smallholders and women, can be difficult, but the challenges are not insurmountable. Scaling new models for extension and bundling extension with other services such as health is an example of increasing opportunities for farmers to access technology and best practices.

Action 2A—Establish a National Science Commission on Global Food Security chaired by the vice president

The president should establish a National Science Commission on Global Food Security led by the vice president that includes relevant government agencies and representatives from land-grant universities, other leading institutions of higher education, business, and NGOs. Its mission should be to identify necessary steps to ensure that both domestic and global agricultural sciences and related disciplines are working toward the goal of sustainable global food security, with a special focus on disciplines that support sustainable intensification. Ideally, the commission would set national research priorities and make recommendations regarding implementation.

The commission, being composed of both public- and private-sector representatives, would be ideal to identify overlaps and gaps in existing research. Even though private research funding is now nearly triple that of the USDA, it is mainly focused on staple crops—corn, wheat, rice, and soybeans.¹²⁵

Given the economic and national security interests at stake, the commission should be led by the vice president in order to elevate its deliberations and to make certain its recommendations lead to tangible and coordinated actions. The commission should include various government agencies with expertise in food security, nutrition, and development as well as private scientific organizations such as the National Academy of Sciences and the National Research Council.¹²⁶ The participation of senior scientists from the USDA, USAID, FDA, Department of Energy, Environmental Protection Agency, Centers for Disease Control, National Science Foundation, National Institute of Health, and other appropriate agencies should be required.

Congress should also be a partner in creating and serving on the commission. Seats on the commission should be reserved for representatives of the congressional leadership of the House Agriculture Committee; the Senate Agriculture, Nutrition, and Forestry Committee; the House Foreign Affairs Committee; the Senate Foreign Relations Committee; the House Science, Space, and Technology Committee; and the Senate Commerce, Science, and Transportation Committee. Equally, Congress should authorize the commission through legislation. A six-year authorization would allow the commission to accomplish its objectives and give Congress the opportunity to review its work before deciding on its reauthorization if continued work is merited.

Action 2B—Revitalize US agricultural research capacity by doubling funding over 10 years

The United States needs to revitalize its own agricultural research capacity and raise it to the top echelon of national research priorities if it expects to maintain its leadership in agriculture and related sciences. Annual federal US funding for agriculture and related sciences should be doubled over the next 10 years to approximately \$7.4 billion from its current level of about \$3.7 billion.¹²⁷ This would reverse the downward trend that began in the 1970s¹²⁸ and return the United States to a leadership position, comparable to investments being made by emerging economies. For this to be a sustained effort, funding beyond this 10-year period needs to be consistent and predictable.

Public investments in agricultural research have largely stagnated over the previous three decades. The President's Council of Advisors on Science and Technology put it succinctly in a December 2012 report: "The waning public investment in agricultural research in the United States contributes significantly to the risk of losing its international leadership in agriculture."¹²⁹ Further, with global productivity generally linked to US leadership on research and development, meeting the food demands of the world's population will be even more difficult.¹³⁰

Simply increasing funding will not be enough. The United States also needs to ensure agriculture and food research supports competitively awarded, peer-reviewed research, where priorities are set by scientists and key stakeholders together. Currently, about 16 percent of agricultural funding is competitively awarded. Comparatively, this is only 2 percent of the amount of competitive funding given by the National Institutes of Health, and only 6 percent given by the National Science Foundation.¹³¹ The President's Council of Advisors on Science and Technology is calling for a near doubling of USDA's budget for competitive extramural research, taking the funding from \$265 million to \$500 million annually, and a doubling of funding for basic research related to



IRRI

“ While agricultural exports are strong today, global food needs are expected to nearly double as the population grows to nine billion by 2050. The pressure to produce more on the same or fewer acres, while still facing weather, price, and input risk beyond their control, will stress agricultural producers for decades to come. Working lands conservation sits at the very core of our ability to meet these production challenges without sacrificing our vital natural resources. As we know, farming is measured in generations: the most successful farmers are those that can pass along a viable farming operation to their children and grandchildren. ”

Senator Debbie Stabenow (D-MI), 2012

agriculture at the National Science Foundation.¹³² Given the value of competitive funding, policymakers should heed the advice of the president’s advisory science panel.

The wide range of US educational institutions, from the land-grant universities with their agricultural expertise to the 1890s institutions and schools on the cutting edge of technology development, should be at the forefront of US efforts. The networks of US land-grant universities, research centers, national laboratories, and major research colleges and universities, even if not traditionally associated with food production (indicating a pull from other fields and application to food production), have advanced science for decades. They are training grounds for students and scientists from around the world.

Both Congress and the administration must work together to provide stable and predictable funding for food security sciences. Policymakers also confront a fragmented policy process, where multiple actors are unaware of others’ activities. They must overcome this fragmentation through fuller engagement across branches and across congressional committees.

COST: \$3.7 billion annually, scaled up between 2013 and 2023

Box 13 – Congressional efforts to support science education and international cooperation

In the previous Congress, a number of bills were introduced that would support science education and international cooperation. Congress should enact these proposals but should also ensure that agriculture is an included discipline. For example, the STEM (science, technology, engineering, math) Education Opportunity Act would ease the financial burden on students pursuing degrees in the fields of biological sciences, earth and physical sciences, engineering, and geosciences. A second bill, the International Science and Technology Cooperation Act, would create a body under the Office of Science and Technology Policy that is cochaired by a senior State Department official. Its task: im-

prove the international cooperation of science and technology that advances US foreign policy. A third bill, the Global Science Program for Security, Competitiveness, and Diplomacy Act, would establish a new grant program to support competitive research initiatives around global challenges and collaborative research and to build capacity for science and engineering institutions. Each of these bills would strengthen US and foreign research capacity and collaboration, and their consideration should be expedited. This type and level of capacity building and collaboration is needed to solve food insecurity.

Action 2C—Pass legislation to enhance the science of food security

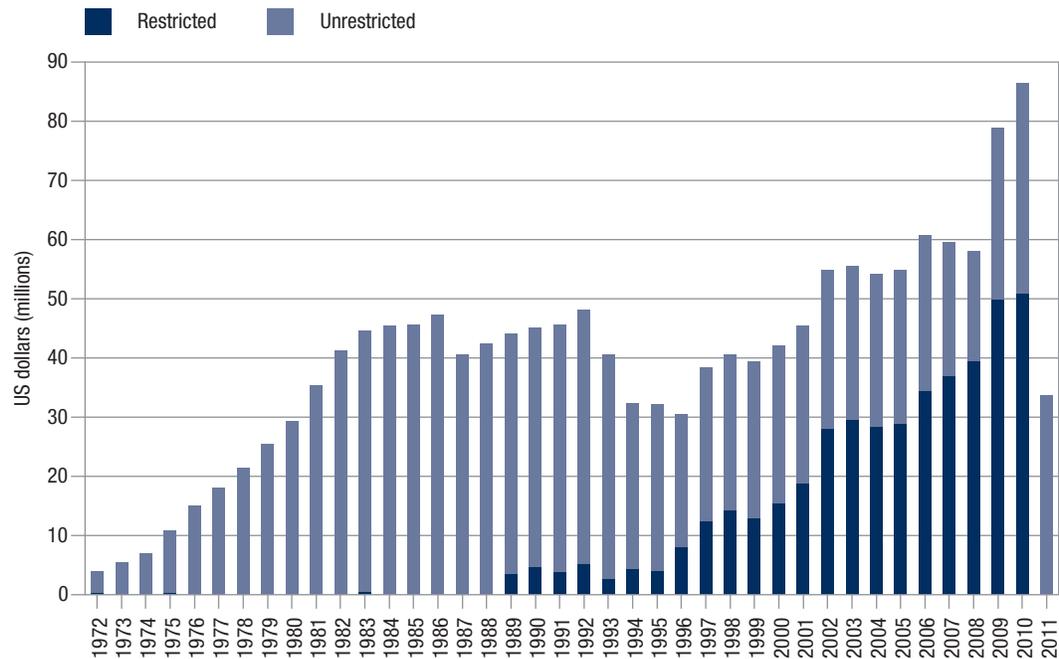
In addition to supporting necessary funding, as called for elsewhere in this report, agriculture should be recognized as an integral part of STEM—science, technology, engineering, and math—disciplines. Many universities and government programs provide special incentives to the next generation to go into STEM disciplines, and those intending to study agriculture, nutrition, and food-related sciences should be considered a part of STEM (see box 13).

Action 2D—Strengthen support for international research institutions

The United States should double its funding for the Consultative Group on International Agricultural Research (CGIAR) system and encourage other donors to do the same (see figure 10). Since the Green Revolution, wealthy countries have supported research aimed at helping smallholder farmers in the developing world by funding international consortia such as the CGIAR. All countries benefit in one way or another from its research. The scientists working throughout the CGIAR network have been particularly effective at putting improved seeds into the hands of the world's disadvantaged farmers. It is working to stop the spread of plant diseases such as wheat stem rust, which threatens up to 80 percent of the global crop.¹³³ Improving corn's resistance to local pests in Africa and devising more effective storage facilities to reduce postharvest waste are just a few examples of global benefits (see boxes 14 and 15).

But this research system is under stress. Although CGIAR funding has increased modestly over time, the money is being diluted by an increase in the number of centers

Figure 10 – US government support to the Consultative Group on International Agricultural Research (CGIAR), 1972 to 2011



Due to a transition in the CGIAR's financial reporting process, data for restricted funding is only available through 2010; data for unrestricted funding is only available through 2011.

Source: USAID, BFS 2012.

Box 14 – Consultative Group on International Agricultural Research centers

Africa Rice Center

Biodiversity International

Center for International Forestry Research

International Center for Agricultural Research in the Dry Areas

International Center for Tropical Agriculture

International Crops Research Institute for the Semi-Arid Tropics

International Food Policy Research Institute

International Institute of Tropical Agriculture

International Livestock Research Institute

International Maize and Wheat Improvement Center

International Potato Center

International Rice Research Institute

International Water Management Institute

World Agroforestry Centre

WorldFish

Source: CGIAR 2013.

Box 15 – AWARD program empowers women in agricultural science

CGIAR is home to the African Women in Agricultural Research and Development (AWARD) program, a two-year fellowship given to African women scientists and professionals engaged in research that benefits rural communities and in particular, women. For example, Sheila Ommeh, a 2008 fellow who grew up raising chickens with her mother and grandmother in Kenya, is a PhD fellow at the International Livestock Research Institute in Nairobi and is working on introducing a disease-resistant chicken using indigenous breeds that can be easily produced by women farmers. Onome Davies, a 2009 fellow, aspires to fight poverty in Nigeria and Africa by increasing fish production. She

has already established the African chapter of the World Aquaculture Society and worked to include Nigeria in an aquaculture program of the American Soybean Association's International Marketing Office in Bangkok, Thailand.

AWARD was established on three pillars. The first is pairing fellows with mentors in an effort to pass on existing knowledge and expand the pool of beneficiaries from the program. The second is helping the fellows build scientific capacity and an international network. Finally, fellows are expected to serve as role models for young girls, building leadership capacity and inspiring younger women to take up careers in agricultural science.

Source: AWARD 2011.

as well as the growth in areas of research.¹³⁴ The total level of CGIAR funding is far from burdensome for its donors, particularly when it is measured against the widespread results it produces. In 2009 funding for CGIAR was just 1.6 percent of global food and agricultural R&D investments in the public domain and less than 1 percent when private research is included.¹³⁵ Additionally, CGIAR's funding is growing more restricted because donor countries are attempting to micromanage which research areas receive their support.¹³⁶ With its activities driven by the agendas of its donors, important research is deprived of adequate support. Although some reforms were initiated in 2010, it is far from certain that this trend will disappear.

COST: \$86 million annually, scaled up between 2013 and 2023

Action 2E—Increase funding for partnerships and educational exchanges between universities in the United States and universities in the developing world

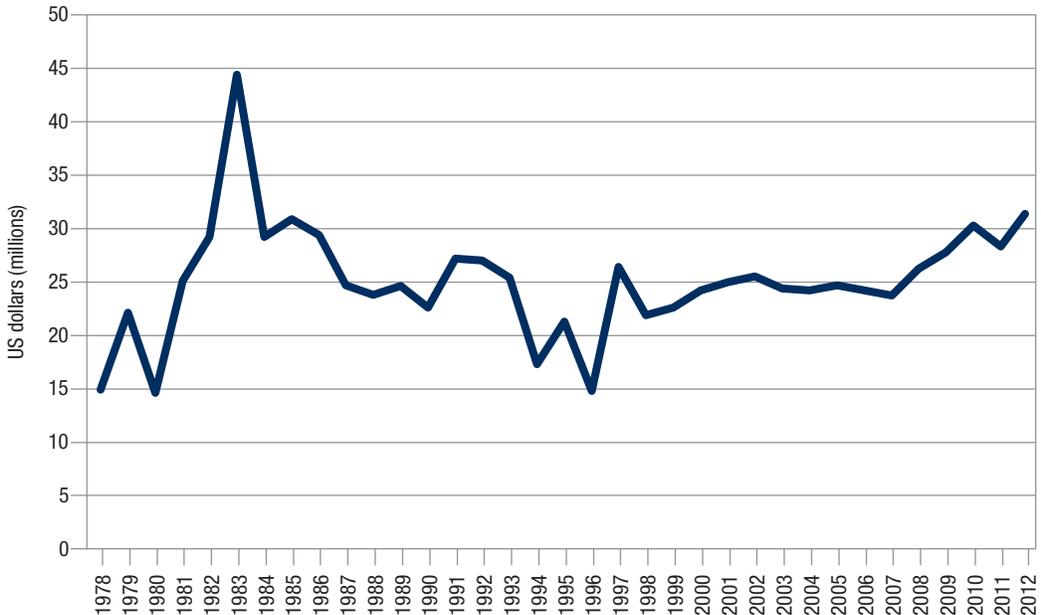
As part of Feed the Future, Congress and the administration should allocate \$300 million annually for capacity building and exchanges. These types of programs should respond to needs identified by developing countries. Strengthening the capacity of foreign researchers, science centers, and government ministries will fuel innovation and economic growth. Scientists from all regions of the world must be able to work together on food security solutions. The localized and varied ecosystems around the world present their own productivity challenges. What affects productivity in one location can

be different in another. With the engagement of foreign scientists, local problems and conditions can be more fully integrated into a food security science research agenda. US embassies and USAID missions should make available informational resources on potential partnerships with US research and educational institutions.

The training of foreign scientists and strengthening of higher education and research facilities was once a focal area of US foreign assistance and public diplomacy, but has since declined. Educational exchanges, once a cornerstone of US programs, served numerous purposes, from building a cadre of trained scientists and educators to promoting respect for democratic institutions to improving attitudes toward the United States (see box 16). At the same time, returning graduates enriched their home universities, often becoming faculty members and even political leaders. Academic communities in many developing countries lament the steep drop-off in opportunities to train students at US institutions. In the past, US investments in strengthening foreign universities produced a number of schools that became leaders in agricultural science. Many of these same institutions are now struggling to maintain facilities and attract faculty and students to their programs.¹³⁷ With run-down facilities, outdated labs and equipment, and underutilized faculty, they are unable to be engines for growth in their own countries and to participate in the renewed focus on agriculture.

As developing countries create, and in some cases renew, their capacity to engage in scientific work, the collaboration between United States and their scientists can be fully realized. Continued leadership by USAID, working with the USDA, is needed to redesign and strengthen a network of universities and research institutions for joint research projects, educational exchanges, and capacity building at foreign universities to educate

Figure 11 – US government support to the Feed the Future Collaboration Research Innovation Labs, 1978 to 2012



The Feed the Future Collaboration Research Innovation Labs were formerly called the Collaborative Research Support Programs (CRSPs).

Source: USAID, BFS 2012.

Box 16 – The West Africa Center for Crop Improvement trains the next generation of plant breeders

Driven by a desire to train African plant breeders in a local context, Cornell University partnered with the University of Ghana in 2007 to establish the West Africa Centre for Crop Improvement (WACCI). With the support of the Alliance for a Green Revolution in Africa, WACCI seeks to improve food security by equipping local plant breeders with the tools necessary to produce improved varieties of West and Central Africa's indigenous crop staples.

The five-year PhD program, which began in January of 2008 with 10 students from five countries, aims to train 40 West and Central African students in plant breeding and genetics. The first two years of the program consist of foundational plant breeding science study at the University of Ghana under the direction of Cornell faculty, University of Ghana faculty, and other visiting scientists.

WACCI students then return to their home countries to conduct thesis research projects designed to address local farmers' challenges in growing crops like maize, sorghum, cassava, cowpeas, and tomatoes.

In addition to teaching courses, Cornell faculty also provide technical and research assistance to WACCI students. Resources from the university's library are available electronically, and all plant breeding courses taught at Cornell are either streamed online or provided in print in Ghana. Faculty from both Cornell and the University of Ghana collaborate to review student research proposals and thesis work, preparing a new generation of West and Central African plant breeders to tackle local challenges with innovative solutions.

Sources: WACCI 2012; Ramanujan 2007; Cornell University Library 2013; WACCI 2013.



a new generation of scientists and educators. This should include land-grant, 1890s, and other major research universities. The farmers that will feed the world in 2050 are 13 years old today. There needs to be new ways to get them excited about being part of the solution to world hunger and build know-how at the local level. Additionally, the strong global demand for food creates an unprecedented need for young talent in roles that people may not immediately relate to food and agriculture—including health, law, development, finance, engineering, and information technology.¹³⁸

Much of this occurs through USAID’s Feed the Future Collaborative Research Innovation Labs (formerly the Collaborative Research Support Programs or CRSPs), in which US Title XII universities lead research on foci including aquaculture, livestock management, nutrition, sustainable agriculture, and natural resource management (see figure 11 and box 17). The Innovation Labs have reportedly refocused their work on contemporary issues confronting farmers around the world, but more can be done to ensure that the topics of research have applications and relevance to smallholders. Consideration should be given to designating a university in an emerging economy as a lead Feed the Future Collaborative Research Innovation Lab facility to better link US and foreign universities on a common research agenda. Because of the priority to maintain a focus on the most vulnerable, a new Innovation Lab should be created around smallholder farming, or alternatively, a smallholder component should be incorporated into existing Innovation Labs.

The nature and priorities of these partnerships should be determined and driven by developing country institutions, with US education and research institutions support-

Box 17 – Feed the Future Collaborative Research Innovation Labs

Adapting Livestock Systems to Climate Change Innovation Lab

(Colorado State University)

Aquaculture and Fisheries Innovation Lab

(Oregon State University)

BASIS Assets and Market Access Innovation Lab

(University of California, Davis)

Global Nutrition Innovation Lab

(Tufts University)

Grain Legumes Innovation Lab

(Michigan State University)

Horticulture Innovation Lab

(University of California, Davis)

Integrated Pest Management Innovation Lab

(Virginia Polytechnic Institute and State University)

Peanut and Mycotoxins Innovation Lab

(University of Georgia)

Sustainable Agriculture and Natural Resource Management Innovation Lab

(Virginia Polytechnic Institute and State University)

Sorghum and Millet Innovation Lab

(US university lead to be determined)

The Feed the Future Collaboration Research Innovation Labs were formerly called the Collaborative Research Support Programs (CRSPs).

Source: USAID, BFS 2013.

Box 18 – Biofortification as a solution to malnutrition

The United Nations estimates that micronutrient deficiency affects over half the world's population. According to the World Health Organization, 250 million preschool children suffer from vitamin A deficiency, which is the number one cause of preventable childhood blindness and considerably increases the risk of severe illness and death from infections. Anemia, often caused by iron deficiency, afflicts two billion people worldwide, stunting physical and cognitive development, increasing childhood disease, and reducing adult productivity. Zinc's active role in more than 200 enzyme systems makes it essential to survival, and its absence negatively impacts growth, development, and incidence of infection, ultimately killing more than 400,000 children each year. Each of these nutritional disorders disproportionately impacts women and children in the developing world. Heavily reliant on starchy staples like maize, wheat, and rice, diets in the developing world too often lack the micronutrients vital for health and development.

Biofortification has emerged as a solution to the challenge of micronutrient deficiency. Other strategies, including nutritional supplementation and commercial food fortification, have successfully reduced malnutrition in targeted areas, but their high cost and limited reach have prevented widespread effectiveness. Biofortification draws on conventional breeding methods as well as modern biotechnology to develop micronutrient-rich varieties of staple food crops widely grown and eaten throughout the developing world. Once improved varieties have been developed and adopted, the crop can be grown for years, making biofortification sustainable and cost-effective. Research has already demonstrated that this process is possible without reducing crop productivity or resilience.

Fortified varieties of crops like sweet potatoes, cassava, maize, wheat, and rice are now emerging throughout Sub-Saharan Africa, South Asia, and Southeast Asia with great impact. HarvestPlus and its partners introduced the vitamin A-fortified orange sweet potato (OSP) in Uganda and Mozambique in 2007 with spillover into a dozen more Sub-Saharan African countries on a continent where an estimated 32 percent of the population is vitamin A-deficient. A British Journal of Nutrition study showed that the OSP is successful at providing vitamin A to malnourished women and children in Mozambique, and a second study in South Africa revealed that daily OSP consumption delivered more than double the daily recommended amount of vitamin A to children. And the improved varieties are popular; about one-third of all Mozambican sweet potatoes are now vitamin A-fortified, and farmers report high demand for the more nutritious varieties. The International Potato Center is now working closely with HarvestPlus on continued dissemination efforts. HarvestPlus has teamed up with the International Institute for Tropical Agriculture Ibadan in Nigeria and various partners in the Democratic Republic of the Congo to develop vitamin A-fortified cassava. HarvestPlus is working with the Zambia Agriculture Research Institute to develop vitamin A-fortified orange maize, and orange maize is also being disseminated throughout Nigeria. The International Maize and Wheat Improvement Center distributed their quality protein maize, fortified with essential amino acids, in Ethiopia (resulting in significant weight and height improvements in children), and has partnered with HarvestPlus to develop zinc- and iron-enriched wheat varieties in India.

Sources: Nestel et al. 2006; WHO 2013; Nemcova 2012; CIMMYT 2010; Charles 2012; IRIN 2011; HarvestPlus 2013; Hara 2012; IIRI 2013; UN Standing Committee on Nutrition 2004.

ing country-determined goals. USAID and USDA can capitalize on each other's existing relationships with universities and international research centers.

COST: \$300 million annually, scaled up between 2013 and 2023

Action 2F—Encourage donors as well as developing countries to make food security science a priority

Despite the challenges, a renewed focus on global agriculture by the United States, traditional donors, and developing countries has produced a number of successes and promising signs for the future. Many new and old actors, both public and private, are increasing their collaboration. Developing countries understand the value in increasing agricultural development and revitalizing rural economies. They are making agriculture a critical component of their national development strategies. The Comprehensive Africa Agriculture Development Program (CAADP), for example, is an African-led process in which participating African governments commit to two goals—to devote 10 percent of national resources to agriculture and to increase productivity by 6 percent.¹³⁹ This renewed focus on agriculture should be extended to science and research activities. Here are some ways to do this:

First, the agricultural chief scientists should hold regular meetings. The first Meeting of Agricultural Chief Scientists in Mexico under the auspices of the G20 is a welcome development.¹⁴⁰ These meetings should be held at least annually, if not more often, with a secretariat that can maintain a focus on setting a coordinated and complementary research agenda to confront common challenges and then tracking and reporting on progress over time. Such regular meetings hold great promise for finding viable solutions. In order to promote better coordination with US policies, the US representative to these meetings should hold a seat on the National Science Commission on Global Food Security.

Second, the New Alliance for Food Security and Nutrition should adopt science as part of its mission. There is an important role for the private sector in international research efforts and in building the capacity of foreign research institutions. The newly formed Global Leadership Council, part of the G8-led New Alliance on Food Security and Nutrition, is composed of government and business representatives with a mission to incentivize private and public officials to make investments that support agriculture.¹⁴¹ The alliance includes many global and African companies and is ideally suited to add science and R&D investments to its portfolio of deliberations.

Third, the United States should work to ensure that a science and research agenda remains a top priority for future G8 and G20 meetings. These international meetings have proven to be influential in setting goals and commitments on a wide range of international issues. They also provide an opportunity for emerging economies to bring their own experiences to the table and to influence new approaches. Many of these countries have profited from their own continuing investments in agricultural science and are well-positioned to work with developing countries on joint science activities.

RECOMMENDATION 3

Reinvigorate trade as a
food security and
development tool

There is a large body of evidence that shows international trade fuels food security and economic growth. Yet many countries lack the infrastructure to export their goods and face trade barriers that are put up by nations trying to insulate their domestic sectors from foreign competition. In many countries, barriers to trade take the form of burdensome government regulations, protectionist policies, poorly trained custom officials, and transportation and infrastructure deficiencies.

A recent World Bank report asserted that “a tangled web of rules, fees, and expensive services is strangling Africa’s regional trade in food.”¹⁴² The World Bank also reports that just 5 percent of grain or cereal imports to African countries originate regionally.¹⁴³ Africa’s own farmers could feed far more people on that continent if their commodities were allowed to flow freely.

At the same time, developed countries are often unreceptive to the agricultural products of developing countries. Agricultural products, the largest export sector of many developing countries, face significant obstacles to trade with wealthy countries, which impose import tariffs and quotas, nontrade barriers such as a wide-ranging variety of food safety regulations, and subsidies to their own farmers that undermine fair competition. The current trade policy environment gives advanced and emerging economies an advantage in the global marketplace while inhibiting economic growth in less-developed countries.¹⁴⁴

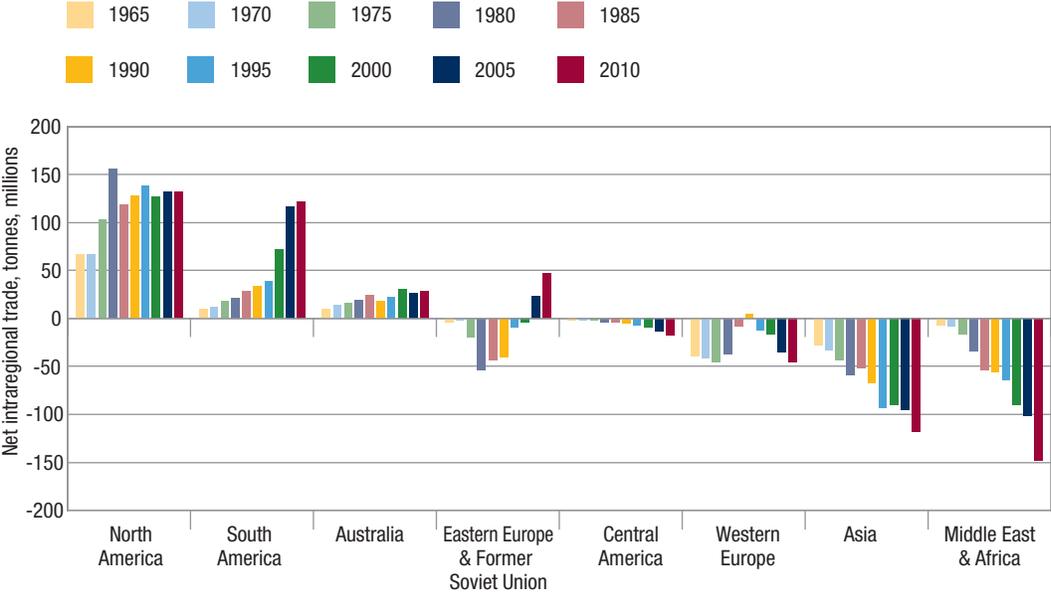
Although the world needs to move to a freer trade system, there is no one-size-fits-all approach. In the initial stages, trade and regulatory policy reform in low-income countries needs to be carefully balanced with the goal of nurturing growth in domestic production. As agricultural productivity in these countries grows, producers will increasingly be able to compete in a regional and global marketplace where goods are freely exchanged.

Freer trade of food can ease disruptions caused by climate change

In order to feed a world of nine billion people by 2050, more agricultural commodities and foodstuffs will need to move across country borders with much greater frequency. Trade will become increasingly important as global warming changes growing seasons, which will shift some farm production out of existing areas to new regions.¹⁴⁵ Increasing weather variability, in which the frequency of droughts and floods increases in major farming regions, will likely shrink harvests in these areas but increase yields in regions north of the current farm belt. The global trade system will need to be modernized to allow foods to efficiently move from areas of surplus to those of deficit. Protectionist trade would aggravate the volatility of food prices. The world got a taste of this when a quarter of the world’s governments imposed export bans in response to rising food prices in 2008, further fueling market volatility (see figure 12).¹⁴⁶

The benefits for US producers, businesses, and consumers of increased trade would be significant. At the most basic level, free-flowing trade helps stabilize food prices, which makes it easier for families to stay within budgets and farmers to decide what to plant. US businesses would have greater access to new and emerging markets. And, a more politically stable world will require less military interventions, in addition to the prospect of a reduced need for US foreign assistance and food aid funding.

Figure 12 – Regional food surpluses and deficits, 1965 to 2010



Source: *The Economist* 2012.

The benefits of trade for poor countries and their farmers are equally powerful. Connecting farmers in developing countries to markets can help their incomes grow, giving them the resources and confidence to invest in productivity-enhancing innovations. Improved inputs—from new seed varieties to affordable irrigation systems—would be more readily traded across borders. Local businesses would likewise view investments more positively in a period of sustained economic growth.

Regional trade agreements present a renewed opportunity to advance free trade

The Doha Round of the World Trade Organization, which was launched with the goal of lifting the economies of developing countries, was meant to hold all countries to the same rules. A successful Doha Round would require wealthy countries, for example, to reduce or eliminate the farm subsidies that poor nations cannot afford to give their farmers.

The stalling of the Doha Round should not prevent other opportunities for trade agreements. The United States has rightly shifted its focus to creating a Trans-Pacific Partnership¹⁴⁷ (TPP) trade framework that offers a new vision that could be applied to other regions. In addition, the president recently announced plans to pursue a US–European Union free trade agreement.¹⁴⁸ These two vehicles—the TPP and a US–EU pact—offer unique opportunities to reform agricultural policies and to undertake changes to the current trade regimes.

A regional approach could advance a trade system while avoiding the difficulties of WTO negotiations or a multitude of bilateral agreements. Regional trade agreements, especially using the comprehensive Trans-Pacific Partnership model, could also be a catalyst for strengthening regional trade among developing countries. Such a model

can create a demand-driven dynamic for removing many of the regulatory burdens that hamper cross-border trade. President Obama's call for a US–European Union trade pact in his 2013 State of the Union address, for example, could help developing countries if it results in a better harmonization of trade rules and regulations that provide better access to the markets of wealthy countries while mitigating the initial costs of complying with international regulations.¹⁴⁹

The barriers to trade are not just centered on trade agreements, tariffs, and duties. There are significant hurdles to overcome in the form of infrastructure (see recommendation 4) and the capacity to standardize and harmonize burdensome or outdated regulations that impede the flow of technological advances across borders. Much evidence points to counterproductive and inconsistently enforced government regulation that prevents cross-border trade in both agricultural inputs and outputs. Corruption at customs offices or poorly trained staff can discourage trade. Even government policies on the approval of new seed varieties can take an inordinately long time and can be duplicative of the same processes in neighboring countries. Many African farmers are denied access to improved seeds used in neighboring countries because of bottlenecks in their government's approval process.¹⁵⁰ Likewise, differing standards for food safety and sanitation rules hinder trade in commodities and processed food.



For us in Africa, indeed for the rest of the developing world, the ultimate solution to the seemingly chronic problem of hunger does not lie with food aid, however reliable the sources may be. The ultimate solution lies in the improvement of our agriculture. I believe if we succeed in fixing African agriculture, there will be no more hunger on the continent.



Jakaya Kikwete, President of Tanzania, 2007





Technoserve

“ *As the world population increases, we must continue our scientific effort in agriculture research and innovation, and we must not simply produce more food; we must also improve access to and consumption of healthier foods. These goals need to be achieved while we work to restore natural ecosystems that are fundamental to sustaining life on earth.* ”

Senator Patrick Leahy (D-VT), 2012

Removing barriers to trade, both physical and regulatory, must be a primary goal for the US government. The tradition of viewing trade in terms of narrow, competing interests must be replaced with the vision of a broad global system that brings its own powerful economic and security benefits.

Action 3A—Identify and address barriers to trade and agricultural development

The United States should conduct a thorough review of its policies that impede trade and agricultural development. The review should include the use of subsidies, import barriers, export restraints, and energy policies, among other things. Policies that impede trade should be adjusted or replaced with policies that help to increase trade in agricultural commodities and food. Particular emphasis should be given to policies that impede trade between rich and low-income countries. The United States should encourage other G20 countries to also conduct reviews and amend their trade policies accordingly.

A review of current policies could be a launching point to discuss how to move forward with World Trade Organization (WTO) negotiations in which freer movement of agricultural trade should be a top goal. This group proposes that product-specific, trade-distorting income and support programs such as countercyclical and loan defi-

ciency payments, crop price supports, and disaster payments be replaced with a new menu that complies with WTO green box rules.¹⁵¹

Biofuel production should eventually rely on market dynamics and biofuels production growth on the use of nonfeed crops. Evidence suggests that the diversion of food crops to biofuels that occurred in 2007 and 2008 was partly a result of an increase in petroleum prices near current levels.¹⁵² Current law mandates that 36 billion gallons of renewable fuel be used by 2022 with no more than 15 billion gallons of that coming from corn.¹⁵³

US biofuels policy should be studied carefully with the intention to support innovation in next-generation energy sources. Research has progressed on the use of agricultural residues such as corn stover and also from nonfood plants such as switchgrass or miscanthus, which can possibly be grown on inferior soils. The use of agricultural residues and cellulosic crops as a fuel source could help achieve a net reduction in greenhouse gas emissions. In addition, US policies should be implemented in a manner that is more sensitive to the weather and the size of US stockpiles. In times of tight supplies such as in the wake of a drought or flood that slashes the size of the US corn harvest, the federal government should evaluate whether to ease its biofuel mandate, providing a relief valve for the grain market.

Action 3B—Use regional trade pacts to increase trade opportunities

Efforts to facilitate greater regional trade in low-income countries should be expanded. The TPP currently being negotiated among 11 countries is an attractive model.¹⁵⁴ Its attention to comprehensive market access, regional trade promotion, regulatory coherence, competitiveness, business facilitation, development, economic growth, and openness to new members are equally appropriate to other regions. While current TPP negotiations are tackling market access across a full range of sectors, the partnership should ensure that trade in agriculture is a central feature.

These TPP features could be used in trade pacts with African nations and regional entities. The recently announced US–East African Community (EAC) Trade and Investment Partnership could follow the TPP model in its comprehensiveness and adaptability for expansion to new members.¹⁵⁵ Negotiations with other African regional economic communities—or RECs—could proceed separately or as part of an expanded US–EAC framework and would set the stage for more comprehensive agreements such as regional free trade agreements or bilateral treaties. Main objectives of such frameworks should be to facilitate regional trade among REC countries and link small-scale farmers to national, regional, and international markets.

Action 3C—Empower regional economic communities to reduce trade barriers

US policies should encourage regulations that promote science-based standards for evaluating new technologies and products that facilitate two-way trade. There are increasing efforts to standardize trade and regulations regionally. Regional economic communities offer an appropriate vehicle for harmonizing regulations and reducing trade barriers.¹⁵⁶ These organizations could also set standards and harmonize the

approval process for new technologies and agricultural inputs, removing redundancies and speeding up the process while still upholding safety. The Codex Alimentarius, a collection of internationally recognized standards, the International Plant Protection Convention, and the World Organization for Animal Health all offer platforms for nations to work toward harmonizing standards for protecting human, plant, and animal health.

There are a number of regional economic communities in Africa that promote economic growth and integration among their member states. RECs have the potential to be a driving force in removing trade barriers and reforming regulations within their regions. A common approval process for improved seeds, for example, would greatly contribute to farmer productivity within those regions. Common phytosanitary standards would facilitate trade.

Action 3D—Incorporate Africa Trade Hubs into Feed the Future

USAID's Africa Trade Hubs focus on the regional aspects of trade. The three hubs—Southern Africa, East Africa, and West Africa—are small programs with both a trade and business development focus.¹⁵⁷ These hubs are separate from Feed the Future and not all of them have a strong food security component. They should be evaluated for possible scaling up of their agriculture portfolios.

They also offer great benefits in promoting a regional approach to business investment and expansion and regional integration. As such they are an ideal tool to tackle the regional regulatory environment that prevents the free flow of technology and farm inputs that increase productivity. Further, differing food safety requirements among neighboring countries prevent the free flow of foodstuffs across borders. Africa Trade Hubs could contribute toward the modernization and harmonization of regulations and standards and in so doing be a force for promoting food security.

Action 3E—Congress should begin work on reauthorizing the African Growth and Opportunity Act and include provisions that will enhance agriculture and food security

Congress and the administration need to begin work on reauthorizing the African Growth and Opportunity Act (AGOA), which is set to expire in 2015. AGOA provides duty-free and quota-free access to the US market by African countries and is heralded for increasing two-way trade in a vast array of sectors, including processed agricultural products.¹⁵⁸ Beginning work on a renewed AGOA in 2013 will send a powerful signal that the United States remains committed to improving trade relations with Africa.

AGOA should include provisions that clear the way for African exports of agriculture-related products and processed foods. A key component would be to help African countries meet US sanitary and phytosanitary (SPS) requirements.

Action 3F—Make food aid more efficient and cost-effective to save more lives and improve food security

The United States is the world's largest donor of food aid to help hungry people, a matter of justifiable national pride. Yet several long-standing practices in the way

the United States delivers food aid undermine the cost-effectiveness and efficiency of its humanitarian programs. Limits on the US ability to support local and regional purchase of food aid, the practice of monetization, and costly cargo shipping requirements encumber the food aid program with time-consuming and complicated bureaucratic measures that decrease the amount of food aid delivered overseas. A recent Government Accountability Office report found that the process of using cash to procure, ship, and sell commodities costs \$219 million out of a total budget of \$722 million over a three-year period.¹⁵⁹

To make food aid more efficient and cost-effective, the United States should transition to a cash-based food aid system. The US government should also end monetization. It should give cash directly to NGOs to replace the funds they would have been provided through monetization. These policy changes will allow the greatest amount of US food aid dollars to go toward alleviating poverty and hunger and, most importantly, toward saving lives.

“ [In 2006], CARE made the decision to transition out of . . . an inefficient and unsustainable program of monetizing commodities to support our development programs. We did not make this decision lightly, recognizing it would affect CARE’s own finances, but we believed it was the right thing to do in the long run to help eliminate chronic hunger and malnutrition around the world. ”

Since that time, we have been advocating [that] the US government . . . change the way it does international food aid programming, including ending policies that rely . . . on monetization for development resources.

Helene Gayle, President and CEO, CARE USA, 2013





RECOMMENDATION 4

**Make market access
and partnership with
business a pillar of food
security policy**

Agriculture has flourished over the last century where sound governmental policy and public investments made it possible for entrepreneurs to pursue their dreams. Government, NGOs, civil society, and international organizations have long championed the cause of agricultural development and will be indispensable to achieving food security. However, this study concludes that the recent trend of partnering with business in the quest to increase food production sustainably in the developing world must be ramped up. Food security cannot be achieved in the developing world without the energy and innovation of the private sector.

The precarious position of smallholder farmers means they have very little economic power when dealing with large enterprises that want to sell them inputs or purchase the crops and livestock they produce. While this report recommends improving the enabling environment for increased private investments, attention should be given to ensure that those investments support rather than displace smallholders. Farmer associations and cooperatives are proven models for empowering smallholders and are familiar to US agribusiness. Businesses must also conform to the United Nations Global Compact on Human Rights, especially on issues related to land tenure, gender equity, and child and forced labor.

The US government needs to make market access for business a central pillar of its relations with governments in the developing world. Regulatory reform is crucial to improving the business climate across Sub-Saharan Africa and South Asia. Recent studies show that when governments establish sound and fair laws and business regulations, economic growth follows.¹⁶⁰

International companies are already investors in the developing world. The amount of private investment flowing there from the business sector in OECD nations towers over the money flowing from the industrialized world in the form of official aid, philanthropy, and remittances. Nearly half of the \$703 billion that moved from OECD member nations through these four categories into the developing world in 2010 was private investment.¹⁶¹ Clearly, private investment could be a ripe source of funds for agricultural development. Equally important is the array of domestic businesses that are engines for employment and growth. These home-grown entrepreneurs need a business-friendly environment in order to expand their operations and create new ventures.

Business will need to invest more in developing countries if that part of the world is ever to achieve food security. For that to happen, governments there must do more to establish well-functioning and transparent markets. Burdensome government regulations, corruption at border crossings, inadequate credit, weak laws, and poor infrastructure hinder private investment and the movement of goods. According to one recent report, moving products overland from Dakar, Senegal, to Ouagadougou, Burkina Faso, involves passing through 55 checkpoints that can add as much as 11 to 17 days in transit time. In other countries, burdensome procedures at export facilities can take more than a month to complete.¹⁶² These barriers to investment must be reduced.

Africa, where economic growth rates are forecast to reach 7 percent annually by 2015, can be an even more fertile ground for private investment.¹⁶³ High growth rates provide the initial attraction, but other factors must be addressed in order to create a business-friendly environment. The World Bank's "Doing Business" report, which ranks countries on rule of law, regulatory burden, and trade, is illustrative. Only seven African countries scored above the median, and four of these are countries credited with

Box 19 – The United States is improving as a development partner

According to a recent study, local leaders in developing countries are noticing a positive change in US development policy. Key findings include:

- 83% of survey respondents said the United States is aligning better with national government plans.
- 75% said the United States is aligning better with the needs of people in countries.
- 77% of stakeholders said their interactions with the United States have improved.
- 73% percent of survey respondents noticed an increase in US capacity-building efforts in their country.

Source: Oxfam 2013.



Jennifer Burney/Stanford University

One of the programs I am proudest of is the effort that began under President George W. Bush with robust congressional support to combat AIDS in Africa. Millions of human beings are alive today because the United States and others in the global community are paying for their antiviral medications . . . We need to continue this kind of foreign aid investment not just in PEPFAR, but in malaria control, vaccine programs, and agriculture initiatives so that we can make similar strides in preventing hunger and establishing a healthier global community.

Senator Marco Rubio (R-FL), 2012

making progress on fighting hunger and poverty—South Africa, Rwanda, Botswana, and Ghana.¹⁶⁴

Action 4A—Incorporate the voice of business in US approaches and country development strategies

Country strategies developed in partnership with low-income countries should explicitly incorporate opportunities for market analysis to identify barriers to investment and include the voices of both women and men within civil society and local government. US development strategies should recognize that agriculture is a business, regardless of the size of the operation, and should encourage policy reforms that enable private investment. The voice of private business—which ranges from women and men in local, national, and regional businesses, civil society, and farmer cooperatives to multinational corporations—is often absent when developing countries and international

donors are devising growth and development strategies, and consequently their valuable insights go missing.

Listening to the concerns of business should happen at two levels. First, US policymakers need to incorporate business concerns in order to design policies and approaches that are conducive to a positive role for business in agricultural development globally. Most international businesses conduct market analyses to determine if entering a potential market is advisable. Such an analysis identifies the barriers that would prevent them from making an investment. The creation of a Business Advisory Board, similar to the existing Board for International Food and Agricultural Development (BIFAD) that currently advises USAID, could be useful for this purpose.

Second, the views of local business, including farmers, should be incorporated into country development strategies, including those of the United States and in the developing countries where these businesses are located. Local businesspeople know their markets well and can be helpful in identifying the types of public investments that are necessary for them to expand or create new businesses. Current models of assistance that incorporate collaboration with aid recipient countries—such as the Millennium Challenge Corporation and the Partnership for Growth model—are to be commended, but they could be strengthened by including the input of the private sector (see box 19).

Action 4B—Support developing countries in reforming property rights and land tenure

Government reforms are necessary so that businesses, from the one-hectare farm to the international conglomerate, have confidence that their investments have a chance to succeed. Good governance in the form of country leadership, respect for the rule of law, recognition of contract rights, and protection of private property, especially in the cases of land and property rights of women, are critical conditions that businesses look for when making investment decisions. US ambassadors, with support from the US embassy country team, are ideally suited to encourage the in-country policy reforms necessary for businesses, large and small, international and domestic, to have the best chance to grow.

A legal framework that respects property rights, including clear land title, especially for women and girls, must be in place before improvements in infrastructure, trade capacity, and access to credit can make much of a difference. Farmers are less likely to improve their operations when they do not have clear title to their land. Yet in many parts of the world, land tenure is tenuous, and in some countries land cannot be privately owned. All too often, women are denied the right to own or inherit land even when they are heads of the household.¹⁶⁵ In promoting policy reforms that are conducive to private investments, the United States should include the property rights of women and their access to finance and education.

The Millennium Challenge Corporation's attention to property rights and land tenure has motivated the adoption of legal and regulatory reforms in a number of countries in Africa and Asia.¹⁶⁶ Its model of incentivizing policy reforms should be incorporated into all Feed the Future focus countries.

Recent interest in so-called land grabs, in which large tracts of farmland are leased to government or corporate entities on concessional terms, with the crops destined for the leasing entity country, has generated concern. There are numerous reports of

Box 20 – The Millennium Challenge Corporation improves infrastructure and extension

The Millennium Challenge Corporation (MCC), a Bush administration initiative established in 2004, is the youngest of America's development assistance agencies. It operates by making bilateral, five-year grants to a short list of qualifying countries selected on the basis of a demanding set of 17 performance indicators. The grants are based on detailed "compacts" negotiated between the United States and the recipient governments, outlining the investments to be made by the receiving governments through their own locally established Millennium Development Authority (MiDA). Congress appropriates the full value of the compact before the agreement is signed, and the funds are then disbursed by the MCC in installments.

US agricultural development activities in Ghana have been strong. The pace of US assistance to agriculture in Ghana has accelerated since 2009, both through the MCC and through regular development assistance channels. Although the MCC compact ended in February 2012, its vital work in agriculture has laid a solid foundation for expanded Feed the Future activities.

The MCC Agriculture Project in Ghana was designed to enhance the profitability of both food staple crops (including in the impoverished north) and horticultural crops. The specific interventions included irrigation development, land tenure facilitation (to improve tenure security for existing land users), improvement of postharvest handling and value-chain services (including enhanced government capacity to monitor compliance with

international standards), improvement of credit services, rehabilitation of farm-to-market feeder roads (rehabilitating 950 kilometers of feeder roads to reduce transport costs for farmers), and a major effort at training. By the compact's completion, over 66,900 farmers in 30 districts had received MCC-funded training.

The experience of farmers in Suglo Bori Buni in northern Ghana illustrates the MCC's Agribusiness Center approach. In 2008 farmers learned from a government agricultural extension officer that if they could organize into an association of at least 50 members, they would be eligible to participate in the project as a farmer-based organization (FBO). They formed an FBO that was more than 50 percent women and received training, plus a "starter pack" of assets and inputs. Mr. Mustapha Fusheni, chairman of the group, later reported the outcome: "Through MiDA we received incentive packages in the form of three bags of fertilizers, improved seeds, Wellington boots, nose masks, and 30 Ghana *cedis* as land preparation money. They helped us cultivate our farms early enough. We rigorously employed the knowledge and skills acquired through our farming training practices that resulted in increased production." Average maize yields for the group increased to 15 bags per acre (1.5 metric tons), a dramatic improvement over the normal yield of eight to ten bags per acre. Each farmer contributed one bag to be sold for cash that was deposited in a local bank to serve as collateral for the next season's farming loans.

Sources: Millennium Challenge Corporation 2011; Millennium Development Authority, Ghana 2011.

smallholder farmers being driven off the land they and their families have worked for generations. These types of land deals appear to happen less often in countries that protect property rights and land tenure.¹⁶⁷ Two FAO-led efforts to establish international standards—the Voluntary Guidelines on the Responsible Governance of Tenure of Land, Fisheries, and Forests in the Context of National Food Security and the Principles for Responsible Agricultural Investment that Respects Rights, Livelihoods, and Resources—are worth supporting. Neither ventures beyond voluntary guidance, but such efforts often help to generate international norms on acceptable practices.

Action 4C—Utilize the Millennium Challenge Corporation, the World Bank, and regional development bank resources for rural infrastructure projects

The Millennium Challenge Corporation has increased US investments in infrastructure. It should continue, in working with compact countries, to prioritize these types of investments. The World Bank has been a leader over the years in large infrastructure projects. It should evaluate all such projects for their impact on improving agriculture. The regional development banks have also engaged in infrastructure. They should reexamine their lending portfolios for the greatest impact in agriculture. The Global Agriculture and Food Security Program (GAFSP) has not been as active in infrastructure, but it has the capacity to do so given its ability to leverage resources from donor countries and private entities (see box 20).

An enabling environment for private investment requires public investments in infrastructure, especially addressing postharvest loss, telecommunications, and transportation. Businesses want to ensure that products can reach markets, both for export and domestic sales. Increasing farm yields and getting products to market depend on farmers' access to the infrastructure that supports their operations. Small farmers often lack adequate market information such as current prices or even weather information that would affect their crops. With a lack of market information and a poor road system, postharvest loss is unnecessarily high. Projects to increase smallholder farming in an environment that lacks commensurate infrastructure investments will do little good in raising incomes. Examples of opportunities to strengthen infrastructure include efforts to:

- **Reduce postharvest losses. There should be a target in developing countries to halve postharvest losses by 2023 and make it a primary goal of the Feed the Future initiative.** Without adequate infrastructure to store and transport crops, enormous amounts of food are lost on their way from farms to consumers' tables.¹⁶⁸
- **Deploy new innovations. US strategies should understand and support the interconnections of the entire value chain, incorporating even those parts that seemingly do not have an agriculture-specific application.** These so-called “disruptive technologies” allow quicker deployment of applications to a broader consumer base. Given the growing reliance of farmers on cell phones for market information, weather forecasts, and even mobile banking, strategies should identify infrastructure needs such as cellular communications. The International Telecommunications Union estimates that there are more than six billion mobile

Box 21 – Transformational approaches to extension

The Alliance for a Green Revolution: Empowering agro-dealers to equip farmers

The Alliance for a Green Revolution in Africa (AGRA) promotes agricultural growth for smallholder farmers in Africa. These smallholders face a unique set of challenges—high rates of post-harvest loss, steep costs for transportation, poor storage technology, inefficient dissemination of finance and market information, and policies that impede access to markets and trade. In response to these challenges, AGRA seeks to promote an enabling environment for smallholder farmers.

AGRA's Agro-Dealer Development Program (ADP) was established in 2007 as a nontraditional program that takes creative approaches to extension. ADP recognizes that agrodealers (small-farm retailers) can provide more than just seeds and fertilizers to their farming communities. AGRA

partners with local community organizations such as CNFA to provide training to agrodealers in providing extension services to local farmers. As many agrodealers are farmers themselves, they serve as trusted sources of knowledge and best practices on everything from soil quality to climate and pests. Training agrodealers connects inputs with information and disseminates important skills throughout farming communities. So far AGRA has trained more than 10,000 agrodealers.

As these thousands of agrodealers successfully provide enhanced extension services and communities and farmers begin to improve their agricultural productivity, agrodealers will need to increase their supply. As part of the Agro-Dealer Development Program, AGRA also serves as the guarantor for low-interest loans to agrodealers to increase banks' confidence in lending to nontraditional recipients. Additionally, AGRA offers financial management training to loan recipients.

Fundación Paraguaya: Equipping girls for futures in agriculture

"If we want to help the poor farmer, we have to better the lives of rural women."

—Dr. Celsa Acosta, educational director, San Francisco Agricultural School

In a country in which over half of the population works in agriculture, small farmers often struggle to compete in an economy dominated by large-scale agricultural production. To combat the lack of practical vocational training in the country's educational system that would help small farmers thrive in Paraguay's rural economy, Fundación Paraguaya founded the San Francisco Agricultural School in 2002 in Cerrito, Paraguay. Its innovative curriculum combines classroom learning in agricultural theory with hands-on experience in the school's orchards, fields, and dairy compounds. The school also teaches business skills that prepare students to market and sell their products. The

school is self-sufficient, covering costs through profits on the sale of high-quality organic products cultivated by students. Male and female students share the same responsibilities and are offered the same opportunities.

To further focus its efforts on the education of girls, Fundación Paraguaya joined with Fundación Moisés Bertoni to establish an all-girl, self-sustainable educational center in the Mbaracayu forest preserve of eastern Paraguay. The Mbaracayu Educational Center mirrors the San Francisco Agricultural School's commitment to hands-on learning, environmental consciousness, and self-sufficiency. The center provides girls with internship and scholarship prospects, access to rural fairs and markets, the chance to travel throughout South America for conferences, and opportunities otherwise inaccessible to rural Paraguayan girls. These experiences provide girls with a sense of confidence and self-worth that has transformed them into aspiring agricultural, environmental, and educational leaders and role models for their peers.

Digital Green: Engaging smallholders through information and communication technologies

Based in India, Digital Green deploys information and communication technology to provide agricultural extension training to 130,000 smallholder farmers, 70 percent of whom are female, in India, Ethiopia, and Ghana. Extension needs of farmers vary across communities, and while individual visits with extension agents are effective, this approach is also time consuming and resource intensive. As a sustainable alternative, Digital Green has developed a video-based system for sharing, discussing, and tracking adoption of new farming knowledge. Using cheap, portable, Digital Green-developed projectors, village farmers produce eight-to-ten-minute how-to farming videos to share with their communities. These videos are designed and produced by local farmers in the local language in collaboration with local NGOs, allowing farmers to reach widespread illiterate populations—30 percent in Ghana, more than 40 percent in India, and 60 percent in Ethiopia. Digital Green’s farmers view a new video every two weeks, and all videos are posted to a database on the organization’s website, where videos are sort-

ed by crop, region, and method. The Connect Online/Connect Offline (COCO) platform that houses the database allows remote areas with limited Internet and electrical connectivity to access the videos. Businesses, entrepreneurs, and NGOs have also made videos on new products, which can then be tested in the local community and discussed via Digital Green’s feedback system.

The organization launched its “Farmerbook” social network to connect farmers that make videos and allow them to track progress, questions, and adoption of more effective farming methods. Digital Green also created Wonder Village, a Farmville-like Facebook game to connect “Farmerbook” farmers with those in urban areas who use more mainstream social networks, building knowledge and awareness via a virtual agricultural village. One very preliminary study has found farmer incomes to increase substantially by participation in Digital Green activities. The organization will partner with Innovations for Poverty Action to use rigorous evaluation techniques to further clarify impact. Building on their successes in agricultural extension, Digital Green is now piloting delivery of health and education information on similar platforms.

One Acre Fund: Capitalizing on social entrepreneurship to engage smallholders

One Acre Fund is an agriculture organization that currently serves over 140,000 smallholder farmers in Kenya, Rwanda, and Burundi. The organization offers two primary innovations that allow the poorest farmers to double their income per planted acre: a complete service bundle and deep rural distribution.

The One Acre Fund service bundle includes farm inputs, financing, training, and market facilitation. This “market bundle” is delivered by over 800 full-

time staff. Each person has expertise in extension and financing and services 200 farmers. They deliver interactive agriculture training to small farmer groups in the fields where farmers work. This model of extension is helping thousands of small farmers double their farm incomes.

The organization is built to operate like a for-profit business, with farmers paying for all the services they receive. One Acre Fund covers 85 percent of its field operating costs through farmer loan revenue and will break even in its Kenya and Rwanda operations within three years.

AGRA Sources: AGRA 2009; AGRA 2013; Makinde 2011. Digital Green Sources: Gandhi 2012; Digital Green 2010. Fundación Paraguaya Sources: Fundación Paraguaya 2011; Fundación Moises Bertoni 2011; Fundapar 2010. One Acre Source: Hanson 2012.

phone users globally, with much of the recent growth occurring in developing countries.¹⁶⁹ In countries where most poor people do not use traditional banks, cell phones are becoming an effective and efficient banking option. In addition to mobile banking, M-PESA in Kenya allows farmers and others to borrow and repay small loans, leading at least one study to find increased income among smallholders using the service.¹⁷⁰ A microinsurance program in Kenya allows farmers to sign up for crop insurance via mobile phone.¹⁷¹

- **Improve transportation. US strategies should seek to remove logistical impediments to the flow of goods.** Transportation bottlenecks, from poor roads to failing port facilities, pose serious logistical hurdles for the movement of goods. Decaying infrastructure poses significant barriers to both cross-border trade and internal markets. It matters little how much a farmer can raise farm yield if crops cannot get to market in a timely fashion. With Africa's growing urbanization, nations will be pressed to ensure that rural to urban transportation linkages work.

The infrastructure needs of many food insecure countries are extensive and costly to address. With some exceptions, the United States has not invested in large infrastructure-building efforts in recent years. Others such as China, the World Bank, the African Development Bank, and European institutions continue to do so. While this report does not call for large expenditures on infrastructure projects, it does suggest that the United States can facilitate partnerships with other donors and the private sector to incentivize developing country investments in their own infrastructure needs.

Given the expense of transportation projects, it may be worthwhile to explore options for greater private-public partnerships. The “growth corridors” model may represent a way to combine the resources of multiple donors with those of private investors. The Southern African Growth Corridor of Tanzania (SAGCOT) is one example in which infrastructure investments from government and private interests are being made to facilitate the movement of goods within the national market, to port facilities, and across borders. SAGCOT partners believe their model has the potential to generate annual agricultural revenues of \$1.2 billion and create more than 400,000 new jobs.¹⁷² Such an approach, with its many stakeholders, is inherently complex, but this is a promising model and should be rigorously evaluated to identify its value for raising productivity and improving the lot of smallholders.

Action 4D—Capitalize on OPIC to advance the US global agricultural development and food security activities

The Overseas Private Investment Corporation (OPIC) provides project financing and risk insurance to US businesses seeking to invest overseas. It is a self-sustaining, independent US government agency that generates income through fees and interest. Since its creation in 1969, OPIC has supported \$200 billion in private investment in developing countries.¹⁷³

OPIC should be further utilized to advance the US global agricultural development and food security goals. It should increase its agriculture loan portfolio to \$1 billion in order to fully support the Feed the Future initiative. Annually, it provides or insures loans of \$3.6 billion, of which just \$400 million is in the agriculture sector.¹⁷⁴ The agency

is ideally suited to support financing and risk mitigation for US companies of all sizes that are trying to partner with enterprises in developing countries.

In order to engage in a higher level of agriculture lending, OPIC may need to revisit its criteria for what constitutes acceptable risk. With profits of more than \$200 million each year, it has a sufficient cushion to undertake higher-risk activities.¹⁷⁵

Congress has not passed a long-term reauthorization of OPIC since 2003, instead relying on annual extensions through appropriations bills.¹⁷⁶ Congress should promptly reauthorize OPIC, at which time it could establish agriculture and food security as a priority area for financing.

Action 4E—Support the work of social entrepreneurs

Social entrepreneurs, who typically bring profits back into the community in which they work, can be a good way to supply subsistence farmers with inputs and link them to the marketplace. USAID is beginning to support social entrepreneurs that work with small-holder farmers in some parts of the developing world, and that effort should be encouraged. Likewise, private enterprise and foundations should seek out and support social entrepreneurs (see box 21).



Appendix A

About The Chicago Council on Global Affairs

Founded in 1922 as The Chicago Council on Foreign Relations, The Chicago Council on Global Affairs is one of the oldest and most prominent international affairs organizations in the United States. Independent and nonpartisan, The Chicago Council is committed to influencing the discourse on global issues through contributions to opinion and policy formation, leadership dialogue, and public learning.

The Global Agricultural Development Initiative (GADI), launched in 2008 and expanded in 2010, purposes to build support and provide policy innovation and accountability for a long-term US commitment to agricultural development as a means to alleviate global poverty. It aims to maintain the policy impetus towards a renewed US focus on agricultural development, provide technical assistance to agricultural development policies' formulation and implementation, and offer external evaluation and accountability for US progress on food security. The Initiative is led by Catherine Bertini, former executive director of the UN World Food Program, and Dan Glickman, former secretary of the US Department of Agriculture, and overseen by an Advisory Group comprised of leaders from government, business, civic organizations, academia, and NGOs. For further information, please visit thechicagocouncil.org/globalagdevelopment.

Appendix B

Advisory Group Biographies

COCHAIRS

Catherine Bertini

Former Executive Director, World Food Program, United Nations

Catherine Bertini is a professor of public administration and international affairs at the Maxwell School of Citizenship and Public Affairs at Syracuse University. She is also a senior fellow at The Chicago Council on Global Affairs. For two years she was a senior fellow at the Bill and Melinda Gates Foundation. Bertini previously served as UN under secretary-general for management (2003 to 2005), as executive director of the UN World Food Program (1992 to 2002), and as assistant secretary for food and consumer services at USDA (1989 to 1992).

Bertini is the 2003 World Food Prize Laureate. She was awarded the Borlaug CAST Communication Award in 2011, the Gene White Lifetime Achievement Award for Child Nutrition in 2007, and 11 honorary doctorates from universities in four countries. She was decorated by the Republic of Italy with its Order of Merit. The Republic of Ireland has honored her with its Certificate of Irish Heritage.

Bertini was appointed by President Bush and reappointed by President Obama to the Board of International Food and Agricultural Development. She serves as a member of the board of directors of the Tupperware Brands Corporation, a jury member of the Hilton Foundation Humanitarian Prize, a member of the board of the Stuart Family Foundation, and on the Audit Advisory Committee of UN Women. In 2012 Secretary Hillary Clinton appointed her a member of the Accountability Review Board on Benghazi.

In honor of her work, WFP/USA has created the Catherine Bertini Trust Fund for Girls Education, which supports initiatives in developing countries to educate girls and women. Currently, the Central New York Living History museum displays part of her collection of “Women at Work Around the World.”

Dan Glickman

Former Secretary, US Department of Agriculture

Dan Glickman is the vice president of the Aspen Institute and executive director of the Aspen Institute Congressional Program. Glickman is also the cochair of AGree and serves as a senior fellow at the Bipartisan Policy Center, where he is cochair of its Democracy Project. Glickman serves on the board of directors of many organizations, including the Chicago Mercantile Exchange. He previously served as US secretary of agriculture in the Clinton administration. He also represented the 4th Congressional District of Kansas for 18 years in the US House of Representatives, where he was very involved in federal farm policy on the House Agriculture Committee. He also served on the House Judiciary Committee and as chairman of the House Permanent Select Committee on Intelligence.

In addition, he is the former chairman of the Motion Picture Association of America, Inc. and former director of the Institute of Politics at Harvard University's John F. Kennedy School of Government. Glickman has served as president of the Wichita, Kansas, school board; was a partner in the law firm of Sargent, Klenda, and Glickman; and worked as a trial attorney at the US Securities and Exchange Commission. He received his bachelor's degree in history from the University of Michigan and his juris doctorate from George Washington University. He is a member of the Kansas and District of Columbia bars.

MEMBERS

Doug Bereuter

President Emeritus, Asia Foundation

Former Member, US House of Representatives

Doug Bereuter served as president and chief executive officer of the Asia Foundation from 2004 to 2010. Previously, he served as a member of Congress from Nebraska for 26 years. During his congressional career, he was a leading member of the House International Relations Committee, where he served as vice chairman for six years. He chaired the Asia-Pacific Subcommittee and later the Europe Subcommittee, had long tenures on its subcommittees on Economic Policy & Trade and Human Rights, and was president of the NATO Parliamentary Assembly. He also served on the House Financial Services Committee for 23 years and on the House Permanent Select Committee on Intelligence, retiring as its vice chairman.

Bereuter graduated Phi Beta Kappa from the University of Nebraska and has two master's degrees from Harvard University in both city planning and public administration. He served as an infantry and intelligence officer in the US Army, practiced and taught graduate courses in urban and regional planning, led various agencies and programs in the Nebraska state government, and served one four-year term as a Nebraska state senator. He is a member of The Chicago Council on Global Affairs Global Agricultural Development Advisory Group, the World Affairs Council of Northern California, and the Pacific Council on International Policy. He is a dean's advisory board member at the University of California–San Diego, a member of the International Security Advisory Board for the US Department of State, and a member of the board of the Nebraska Community Foundation. He is also board chairman of the National Arbor Day Foundation.

John Carlin

Visiting Professor and Executive-in-Residence, Kansas State University

Former Governor, Kansas

John Carlin is currently a visiting professor/executive-in-residence at Kansas State University in the School for Leadership Studies, where he has taught executive leadership and practical politics since 2005. During this period, he also served as a member, then chair of the Kansas Bioscience Authority. This authority was created in 2004 for the purpose of advancing the biosciences in Kansas. Carlin also chaired the Pew Trust Commission on Industrial Farm Animal Production. The commission's final report

was issued in 2008 and it continues to help inform policymakers in Washington on key issues facing agriculture and our food supply.

Carlin served 10 years as archivist of the United States after being appointed by President Clinton in 1995. He served two four-year terms as governor of Kansas, leaving office in January 1987. He was chairman of the National Governors Association from 1984 to 1985. Prior to being governor, he served four terms in the Kansas House of Representatives, the last term as speaker of the House. Carlin has a degree in dairy husbandry from Kansas State University.

Wendy J. Chamberlin

President, Middle East Institute

Wendy Chamberlin has been president of the Middle East Institute (MEI) since March 2007. A 29-year veteran of the US Foreign Service, she was US ambassador to Pakistan from 2001 to 2002 and to the Laos People's Democratic Republic from 1996 to 1999. During her ambassadorship in Islamabad, she played a key role in Pakistan's cooperation for the US-led campaign against al Qaeda terrorists in Afghanistan following the 2001 terrorist attacks in the United States. Prior to joining MEI, Chamberlin served as deputy high commissioner for the UN high commissioner for refugees (2004 to 2007), where she supervised the administration of the UN humanitarian organization with a budget of four billion dollars.

During her appointment to the US Agency for International Development (USAID) as assistant administrator in the Asia-Near East Bureau from 2002 to 2004, Chamberlin helped establish civilian reconstruction programs in Iraq and Afghanistan and development assistance programs throughout the Middle East and East Asia. Chamberlin served as director of global affairs and counterterrorism at the National Security Council (1991 to 1993) and as deputy in the Bureau of International Counter-Narcotics and Law Programs (1999 to 2001). Ambassador Chamberlin is a member of the Trilateral Commission. She serves on the executive board of the American Academy of Diplomacy and is a board member of the Hollings Center. She is a graduate of Northwestern University and has an MS in education from Boston University. She holds an honorary PhD from Northwestern University.

Jason Clay

Senior Vice President, Markets, World Wildlife Fund

Jason Clay is senior vice president for market transformation for the World Wildlife Fund (WWF) in the United States. Manager of WWF's private-sector advisory board, Clay is the architect of the WWF's private-sector engagement strategy for commodities and supply chain management issues. He is a thought leader in the NGO community about global trends and supply chain management issues, partnering and convening multistakeholder groups to work together on precompetitive issues. Clay is a globally recognized expert on certification and food production. He created one of the world's first ecolabels and helped develop standards for more than a dozen commodities through multistakeholder processes that reduce the impacts of production. Over the course of his career, Clay has run a family farm, taught at Harvard and Yale, worked for the US Department of Agriculture, helped create hundreds of products such as Rainforest Crunch with Ben & Jerry's, and spent more than 30 years working with envi-

ronmental and human rights organizations. Clay studied at Harvard and the London School of Economics and received his PhD in anthropology at Cornell University. He founded the award-winning *Cultural Survival Quarterly* and is author of more than 300 articles and 15 books. In addition to his WWF role, Clay is the first ever Food and Sustainability Fellow of the National Geographic Society and won the 2012 James Beard Award for his work on the sustainability of global food systems.

Gordon Conway

Professor of International Development, Imperial College London

Sir Gordon Conway is currently professor of international development at the Imperial College London. Conway, knighted by Queen Elizabeth II in 2005, is a world-renowned agricultural ecologist and is recognized as one of the first experts to define the concept of sustainable agriculture. As president of the Rockefeller Foundation from 1998 to 2005, he worked to increase that organization's attention to ecological and food security issues, particularly the promise and challenges presented by biotechnology in the context of world hunger. From 2004 to 2009 he served as the chief scientific adviser to the United Kingdom's Department for International Development (DFID).

Conway's field experience has included pioneering integrated pest management in Borneo in the 1960s and developing agroecosystems analysis in Thailand. From 1970 to 1986 he was professor of environmental technology at the Imperial College of Science and Technology in London. He also directed the sustainable agriculture program of the International Institute for Environment and Development in London before becoming a representative of the Ford Foundation in New Delhi. He is author of several books—including *The Doubly Green Revolution: Food for All in the 21st Century and One Billion Hungry: Can We Feed the World*—and recently stepped down as president of the Royal Geographic Society. He is a fellow of the Royal Society and honorary fellow of the Royal Academy of Engineering.

Gebisa Ejeta

Distinguished Professor of Plant Breeding and Genetics, Purdue University

Gebisa Ejeta is Distinguished Professor of Plant Breeding & Genetics and International Agriculture and serves as executive director of the Center for Global Food Security at Purdue University. Ejeta has been a member of the faculty of Purdue University since 1984. His career has been devoted to education, research, and international development with contributions in human and institutional capacity building, in technology development and transfer, and in advocacy for science in support of the cause of the poor.

Ejeta has served in advisory roles to several international development agencies. He currently serves on the boards of the Consultative Group for International Agricultural Research (CGIAR) Consortium, the Sasakawa Africa Association, and The Chicago Council for Global Affairs Global Agricultural Development Initiative. Ejeta is the 2009 World Food Prize Laureate and a recipient of a national medal of honor from the president of Ethiopia. He is a fellow of the American Association for the Advancement of Sciences, the American Society of Agronomy, and the Crop Science Society of America. Ejeta has served the US government in several capacities, including as special advisor to USAID Administrator Dr. Rajiv Shah and as science envoy of the US State Department.

He was appointed by President Obama as member of the Board for International Food and Agricultural Development (BIFAD) in 2010.

Mark E. Keenum

President, Mississippi State University

Mark Everett Keenum became Mississippi State's 19th president January 5, 2009, following a distinguished public service career. After completing his bachelor's and master's degrees in agricultural economics at Mississippi State (MSU), Keenum joined the university faculty in 1984 as a marketing specialist with the Mississippi Cooperative Extension Service. Two years later, he accepted a position as a research associate with the Mississippi Agricultural and Forestry Experiment Station at MSU. He continued his education at the university, in 1988 receiving a doctorate in agricultural economics. He joined the faculty of that department as an assistant professor/economist.

In 1989 Keenum joined the Washington, DC, staff of US Senator Thad Cochran as legislative assistant for agriculture and natural resources. As Senator Cochran's adviser on agricultural affairs, he worked on numerous issues important to US agriculture, including the 1990, 1996, and 2002 farm bills. From 1996 to 2006 he served as chief of staff for Senator Cochran. In this role Keenum was the chief adviser to the senator on political, legislative, and appropriations issues. He also was responsible for managing all administrative and legislative functions of the senator's Washington, DC, office and three Mississippi offices, including direct oversight of the US Senate Committee on Agriculture, Nutrition, and Forestry and the US Senate Committee on Appropriations. Prior to being named president of Mississippi State in November 2008, Keenum served as under secretary of the US Department of Agriculture for two years, where he provided leadership and oversight for the Farm Service Agency, the Risk Management Agency, and the Foreign Agricultural Service.

Jo Luck

Former President and CEO, Heifer International

In August 2011 Jo Luck retired from her position as president of Heifer International after 22 years with the organization. She served as the organization's president and chief executive officer from 1992 to 2010 and as director of International Programs from 1989 to 1992. Luck is a 2010 World Food Prize Laureate and continues her work to end hunger through speaking presentations and service on boards and advisory committees. She addresses the global food security challenge of feeding nine billion people in 2050 by not only assuring there is sufficient food, but that it is accessible, nutritious, affordable, safe, sustainably grown, and culturally appropriate using scientific research, participatory decision-making, empowerment of smallholder farmers, gender equity practices, and sustainable agricultural development.

In 2011 Luck was appointed to the Board for International Food and Agricultural Development (BIFAD) by President Obama. She serves as a member of The Chicago Council's Global Agricultural Development Initiative Advisory Group and the DuPont Advisory Committee on Agriculture Innovation and Productivity. She is chairperson of the Program Oversight Panel for the Aquatic Agricultural Systems conducted by the WorldFish Center (CGIAR) located in Penang, Malaysia. Luck attended Hendrix College and earned a bachelor of arts in education at David Lipscomb College. She attended

the John F. Kennedy School of Government at Harvard University and Harvard Business School's Executive Education Session on Governing for Nonprofit Excellence. She is the recipient of honorary doctorates from Clark College, Lyon College, the University of Arkansas, and Stephens College.

Earl Pomeroy

Former Member, US House of Representatives

Former Congressman Earl Pomeroy brings 26 years of regulatory and legislative experience to his present position as senior counsel at Alston & Bird LLP. Pomeroy's practice focuses on matters before the legislative and executive branches of government at the federal level as well as work before financial regulators at the state government level.

Pomeroy has been an influential participant in financial services regulation as it has evolved over the last quarter century. More than 20 years ago, as president of the National Association of Insurance Commissioners, he advanced reforms to strengthen solvency oversight in state insurance departments, which were widely adopted, substantially improving the quality of state insurance regulation.

For eight terms he was the only member of the US House to have served as an Insurance Commissioner. This unique background provided the basis and credibility for Pomeroy's active participation in regulatory reform debates held throughout his time in Congress. Drawing upon his background as North Dakota Insurance Commissioner, president of the National Association of Insurance Commissioners, nine-term member of Congress, and senior member of the House Ways and Means Committee, Pomeroy's practice areas include financial services regulation, health care policy, pensions, tax policy, energy, and agriculture.

Beth Sauerhaft

Director of Global Environmental Sustainability, Pepsico

Beth Sauerhaft works on the Long Term Research team in Corporate R&D as the senior director of corporate agro sustainability at PepsiCo, where she carries out long-term risk analysis and strategy development to guide and develop PepsiCo's global policies relating to agriculture, health, and the environment. Her work more specifically focuses on leading towards the integration of health, nutrition, environmental sustainability, and agriculture to reduce risk and raise opportunity for long-term business sustainability.

Before joining PepsiCo in 2007, she worked for the US Environmental Protection Agency (EPA) as the deputy to the agricultural counselor. In that position she provided policy advice to the agricultural counselor, the administrator, and other EPA managers on a variety of agricultural issues cutting across functional responsibilities of the agency. Prior to working at EPA, Sauerhaft worked at the USDA Natural Resources Conservation Service, where she held national leadership responsibility for atmospheric resource quality management issues and before that was a district conservationist in New York.

Sauerhaft is chair of her town's Sustainability Advisory Board and has recently become a member of the board of directors of the Children's Environmental Literacy Foundation. She earned a PhD in Rangeland Ecology and Management from Texas A&M University, with research in arid land agroforestry. She has a master's of environmental

management from Duke University in natural resource ecology and a bachelor's degree in American studies from Grinnell College in Iowa.

Paul E. Schickler

President, DuPont Pioneer

Paul E. Schickler is president of DuPont Pioneer, the advanced seed genetics business of DuPont. In this role, which he has held since 2007, he has continued to expand Pioneer's global business by remaining focused on innovation that improves local productivity and profitability of farmers in more than 90 countries. Since joining Pioneer in 1974, Schickler has served in a variety of finance and administrative leadership roles throughout the business, including vice president of international operations from 1999 to 2007. He currently serves on the DuPont Committee on Agricultural Innovation and Productivity in the 21st Century and the DuPont Agriculture Decision Board, and he is a member of the DuPont Operating Team.

Schickler is a graduate of Drake University, where he received bachelor of science and master of arts degrees in business administration. He currently serves on The Chicago Council on Global Affairs Board of Directors; The Chicago Council's Global Agricultural Development Initiative Advisory Group; the Grand View University Board of Directors; and the Iowa Business Council. A strong contributor to the community, Schickler is an active supporter of United Way, the World Food Prize Foundation, Meals from the Heartland, and the Farm Journal Legacy Project.

Ritu Sharma

President and Cofounder, Women Thrive Worldwide

Ritu Sharma is president and cofounder of Women Thrive Worldwide, a leading organization advocating US policy to benefit women living in poverty in developing countries. With Women Thrive's long-time leadership, global women's issues are now being incorporated into US foreign policy, including agriculture and trade programs. A first generation American of East Indian heritage, Sharma's family left behind generations of violence and poverty in Punjab, India, to build a new life in the United States, where she founded Women Thrive in 1998.

She is author of *An Introduction to Advocacy: A Training Guide*, which has been translated into six languages and is a primary reference for advocates around the globe. She serves on the board of the US Global Leadership Campaign (USGLC) and has been regularly quoted on gender, global women's issues, and US foreign policy in many media outlets, including *The Washington Post*, National Public Radio, *The New York Daily News*, *The Boston Globe*, *The Baltimore Sun*, Fox News' Strategy Room, Washington News Channel 8, and MSNBC. Sharma holds a bachelor of science in foreign service (BSFS) in international economics from Georgetown University's School of Foreign Service and a master's of public health from Johns Hopkins University.

Robert L. Thompson

*Visiting Scholar, John Hopkins University's School of Advanced International Studies
Professor Emeritus, University of Illinois*

Robert L. Thompson is a visiting scholar at Johns Hopkins University's School of Advanced International Studies and professor emeritus at the University of Illinois,

where he held the Gardner Endowed Chair in Agricultural Policy from 2004 to 2010. He is a senior fellow with The Chicago Council on Global Affairs and serves on the International Food and Agricultural Trade Policy Council. Previously, Thompson served as director of Rural Development at the World Bank (1998 to 2002); president of Winrock International Institute for Agricultural Development (1993 to 1998); dean of agriculture (1987 to 1993) and professor of agricultural economics (1974 to 1993) at Purdue University. He was assistant secretary for economics at the US Department of Agriculture (1985 to 1987) and senior staff economist for food and agriculture at the President's Council of Economic Advisers (1983 to 1985).

Thompson received his bachelor of science degree from Cornell University and master of science and PhD degrees from Purdue University. He holds honorary doctorates from Pennsylvania State University and Dalhousie University (Canada). He is a fellow of the American Agricultural Economics Association and the American Association for the Advancement of Science and a foreign member of the Royal Swedish Academy of Agriculture and Forestry and the Ukrainian Academy of Agricultural Sciences. He is a former president of the International Association of Agricultural Economists.

Ann M. Veneman

*Former Executive Director, United Nations Children's Fund
Former Secretary, US Department of Agriculture*

Ann M. Veneman has a distinguished career in public service and currently serves in board and advisory capacities for a number of companies, social businesses, and non-profit organizations. She is a frequent speaker on a range of topics, including food security and nutrition, poverty alleviation, empowering women and girls, and global health.

From 2005 to 2010 she served as the executive director of the United Nations Children's Fund (UNICEF), where she directed a staff of over 11,000 in more than 150 countries around the world. She worked to support child health and nutrition, quality basic education for all, access to clean water and sanitation, and the protection of children and women from violence, exploitation, and HIV/AIDS.

From 2001 to 2005 Veneman was secretary of the US Department of Agriculture (USDA), one of most diverse federal agencies, with an annual budget of \$113 billion and 110,000 employees. From 1995 to 1999 she served as secretary of the California Department of Food and Agriculture. She served in various positions in the USDA, including deputy secretary, deputy undersecretary for international affairs, and associate administrator of the Foreign Agricultural Service from 1986 to 1993.

A lawyer by training, Veneman has practiced law in both California and in Washington, DC. She holds a bachelor's degree in political science from the University of California, Davis; a master's degree in public policy from the University of California, Berkeley; and a juris doctor degree from the University of California, Hastings College of the Law.

Joachim von Braun

Director, Center for Development Research, University of Bonn

Joachim von Braun is director of the Center for Development Research (ZEF), Bonn University, and professor for economic and technological change. He was director general of the International Food Policy Research Institute (IFPRI) based in Washington,

DC, from 2002 to 2009. His main research interests are in economic development and policy; food and nutrition security; and trade, science, and technology policy. He serves on boards of publishers of journals as well as on international advisory bodies for research, corporate, and policy organizations. He also serves on councils of the EU and the German government. He is member of German Academies and of the Pontifical Academy of Science of the Vatican and is a fellow of the American Association for the Advancement of Sciences. From 2000 to 2003 he was president of the International Association of Agricultural Economists (IAAE). His awards include the Justus von Liebig Prize for World Nutrition 2011, the Bertebos Prize by the Royal Swedish Academy of Agriculture and Forestry “for outstanding work in development economics and on food, agriculture, and rural poverty” 2009; and an honorary doctoral degree in agricultural economics from the University of Stuttgart-Hohenheim, Germany 2005.

Appendix C

Acronyms

ADP—Agro-Dealer Development Program
AFSI—L'Aquila Food Security Initiative
AGOA—African Growth and Opportunity Act
AGRA—Alliance for a Green Revolution in Africa
AWARD—African Women in Agricultural Research and Development
BFS—Bureau for Food Security
BIFAD—Board for International Food and Agricultural Development
CAADP—Comprehensive Africa Agriculture Development Program
CDC—Centers for Disease Control
CGIAR—Consultative Group on International Agricultural Research
CIAT—International Center for Tropical Agriculture
CIFOR—Center for International Forestry Research
CIMMYT—International Maize and Wheat Improvement Center
CIP—International Potato Center
COCO—Connect Online/Connect Offline
CRSP—Collaborative Research Support Programs (now called Feed the Future Collaborative Research Innovation Labs)
CTI—Compatible Technology International
EAC—East African Community
EPA—Environmental Protection Agency
FAO—Food and Agriculture Organization of the United Nations
FDA—Food and Drug Administration
FTA—Free Trade Agreement
FTF—Feed the Future
GAFSP—Global Agriculture and Food Security Program
GAO—Government Accountability Office
GIS—Geographic Information Systems
ICARDA—International Center for Agricultural Research in the Dry Areas
ICRAF—World Agroforestry Center
ICRISAT—International Crops Research Institute for the Semi-Arid Topics
IFPRI—International Food Policy Research Institute
IITA—International Institute for Tropical Agriculture
ILRI—International Livestock Research Institute
IMF—International Monetary Fund
IPCC—International Plant Protection Convention
IRR—Internal Rates of Return
IRRI—International Rice Research Institute
IWMI—International Water Management Institute
MCC—Millennium Challenge Corporation
MDG—Millennium Development Goal
MiDA—Millennium Development Authority

NEPAD—New Partnership for Africa’s Development
NGO—Nongovernmental organization
NIH—National Institutes of Health
NOAA—National Oceanic and Atmospheric Administration
NRC—National Research Council
NSF—National Science Foundation
OECD—Organization for Economic Cooperation and Development
OPIC—Overseas Private Investment Corporation
OSP—Vitamin A-Fortified Potato
PCAST—President’s Council of Advisors on Science and Technology
PEPFAR—President’s Emergency Plan for AIDS Relief
PFG—Partnership for Growth
QDDR—Quadrennial Diplomacy and Development Review
R&D—Research and Development
REC—Regional Economic Community
SAGCOT—Southern African Growth Corridor of Tanzania
SPS—Sanitary and Phytosanitary
STEM—Science, Technology, Engineering, and Math Education
STRASA—Stress-Tolerant Rice for Poor Farmers in Africa and South Asia
SUN—Scaling Up Nutrition Movement
TFP—Total Factor Productivity
TPP—Trans-Pacific Partnership
UN—United Nations
USAID—United States Agency for International Development
USDA—United States Department of Agriculture
USTR—Office of the United States Trade Representative
WACCI—West Africa Center for Crop Improvement
WHO—World Health Organization
WTO—World Trade Organization

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