

# Leveraging Innovation to Feed the Future

By Meagan Keefe

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## Executive summary

- ▶ In the 20th century, increased productivity due to cropland expansion and scientific breakthroughs made it possible to grow the global food supply exponentially while keeping prices relatively low for most of the world's consumers. However, this past success is being put at risk at a time when there are significant challenges facing the global food system.
- ▶ The United States should leverage research and training to spur innovations that will overcome future food challenges. The newly established US Department of Agriculture (USDA) Foundation for Food and Agricultural Research, USDA, National Science Foundation, and research universities should reprioritize scientific agendas to recognize the most pressing agriculture and food needs.
- ▶ Research and development (R&D) is essential to sparking the innovations and approaches needed for today's growers and food producers to increase productivity, produce more nutritious food, use fewer resources, and adapt to climate change. Doubling research investments in Sub-Saharan Africa would reduce poverty by 9 percent annually if accompanied by improvements in extension, credit, and input supply systems.<sup>1</sup>
- ▶ While innovation to address today's complex agricultural challenges is crucial, much can be gained from better utilizing existing science. Most Sub-Saharan African countries could potentially access at least 15 times (and, on average, nearly 600 times) their locally produced agricultural knowledge.<sup>2</sup>
- ▶ The United States needs to double investments in agricultural and food research over the next 10 years to help meet these challenges. It can begin by taking the following actions:
  - **Forge a new science of agriculture to increase productivity sustainably, nutritiously, and economically.** Production must be increased while using fewer resources, improving nutrition, and providing solid incomes to food producers.
  - **Build research capacity.** Support for university and research institutions in developing countries is critical to innovations that work in the local context.
  - **Bolster research on climate change.** Research must focus on building resilience and addressing threats to the food system by climate change.
  - **Expand nutrition-sensitive agricultural research.** Nutrition should be a key priority of research to combat chronic malnutrition.
  - **Reduce food waste.** Innovations for reducing food waste are vital to help offset the production needed to meet increased demand.

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## Introduction

To date, the global agricultural system has been largely a success story. In the 20th century, increased productivity due to cropland expansion and scientific breakthroughs made it possible to grow the global food supply exponentially while keeping prices relatively low for most of the world's consumers. Past investments have allowed for the creation of the reliable, affordable, and safe food supply that exists today.

However, this past success is being put at risk at a time when there are significant challenges facing the

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global food system. Globally, over 800 million people are chronically hungry.<sup>3</sup> There are growing constraints on water and land resources, which will make increasing production the way it was done in the past impossible. More than three million children die each year due to undernutrition.<sup>4</sup> At the same time, chronic disease, caused in large part by unhealthy diets, is now one of the leading causes of death worldwide, and these rates are expected to rise.<sup>5</sup>

All of these challenges will be compounded in the years ahead as demand for food rises due to population growth and rising incomes. It is estimated that global production will need to increase by 50 to 60 percent by 2050 to meet the projected increases in demand associated with population growth, urbanization, and changing dietary preferences in a business-as-usual scenario.<sup>6</sup> And, these productivity gains will be needed as rising temperatures, resource scarcity, and the increased frequency of extreme climatic events further challenge global production. Without new strategies to make sure food production can meet demand, the world will face food shortages and higher food prices. The number of people unable to afford a nutritious supply of food will climb. Chronic hunger and undernourishment will continue at current rates and obesity rates will continue to rise. Given the challenges facing agriculture, it is far from assured that agricultural output can climb enough to keep pace

with expected demand unless strong action is taken to alter the global food system.

## The United States must lead a reorientation of the agriculture research enterprise to solve these challenges.

The entire agriculture research enterprise in the United States and around the world needs to focus on solving the future challenges of the global food system. This requires a whole-of-government approach and close partnership with the private sector, which is currently outpacing governments in terms of research dollars. R&D is essential to sparking the innovations and approaches needed for today's growers and food producers to increase productivity, produce more nutritious food, use fewer resources, reduce food waste, and adapt to climate change. These efforts will help build a sustainable global food system. With strong leadership, the world has the ability to prepare

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the global food system for the coming challenges and help farmers adapt to new and changing conditions. With unparalleled expertise, historical experience, and leadership potential at its disposal, the United States can and must rise to this challenge.

## US investment in agricultural research can be transformative for global food security.

Agricultural R&D plays a critical role in equipping the agriculture and food sectors to overcome these challenges. Robust spending on research fueled the dramatic increases in production achieved in the past. R&D investments often have the largest effect on sectoral 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. Research has shown that doubling research investments in Sub-Saharan Africa would reduce poverty by 9 percent annually if accompanied by improvements in extension, cred-

it, and input supply systems.<sup>7</sup> The lag time between research and uptake of technologies is typically very long. Cutbacks in agricultural R&D spending have allowed past productivity gains to slip away as economic and environmental circumstances change to undermine those gains.

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Agricultural science can deliver innovations that will equip the global food system to meet the challenges it currently faces. While the Green Revolution of the 1950s and 1960s transformed agriculture through innovation and technology in some low- and middle-income countries, advances were largely focused on increasing production and did not account for environmental conservation or nutrition. Today's challenges have become infinitely more complex, and a full range of expertise is necessary to address them. Growers and food producers need innovations and approaches that will not only increase their productivity, but help them produce more nutritious food, use fewer resources, and adapt to climate change. They also need innovations to reduce food waste along the value chain. The only way this is possible is to invest in innovation and make sure tested innovations are shared with farmers everywhere.

While innovation to address today's complex agricultural challenges is crucial, much can be gained from better utilizing existing science. Innovation is

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inherently an international endeavor and is based on cumulative science. A more comprehensive view of R&D potential would allow countries to take advantage of existing research and adapt it to fit local conditions. However, the potential for adapting existing information to fit production characteristics and agroecological conditions has typically been neglected in the formation of domestic research policies and

agricultural institutions. Most Sub-Saharan African countries could potentially access at least 15 times (and, on average, nearly 600 times) their locally produced agricultural knowledge by adapting and adopting technologies produced in other countries.<sup>8</sup> There is a clear need for a more international approach to US domestic agricultural research and development practices. Spillover effects and the benefits of international collaboration should be taken into account to help reduce lag time and save resources.

## **Agricultural research spending by high-income countries must be reinvigorated.**

Despite the importance of research for boosting productivity as well as the clear need for increased productivity, current trends in both spending and productivity are going in the wrong direction. The rate of agricultural productivity growth is slowing worldwide, including a dramatic slowdown in the United States. Growth in the United States has dropped by half, from 2 percent in the decades before 1990 to 1 percent after 1990.<sup>9</sup> Accompanying this trend is a sustained slowdown in the growth of public spending on food and agricultural R&D. For almost a decade, the United States has been divesting in this area. After slowing dramatically in the mid-1980s, growth in public agricultural research spending peaked in 1994 and has since declined by more than 20 percent.<sup>10</sup> Stagnating public investment in research is already making it more difficult for producers to adapt to droughts, floods, new pests, and emerging diseases. Multifactor productivity in US agriculture has been in decline, dropping by nearly half from 2.12 percent per year during 1949 to 1990 to 1.15 percent per year from 1990 to 2007.<sup>11</sup>

While the private sector has picked up some of the slack in R&D in recent decades, there is no substitute for public-sector research, much of which focuses on “basic” research that builds knowledge without specific applications in mind but feeds into future innovations. Around 43 percent of private-sector R&D in the US over the past two decades involved “applied” research in the areas of food processing, beverages, and tobacco, where there is more immediate commercial potential.<sup>12</sup> Given the stagnation in public-sector investment in research, this leaves a huge deficit in basic research, which is necessary to develop the building blocks for broader solutions to challenges in the food system. While the private sector will play an



important role in helping to meet the current challenges facing our food system, many of the challenges will remain unaddressed without the basic research on which so much other research and innovation relies.

Further, the United States and other high-income countries are losing their edge in R&D spending to China and others. In 1980 the United States was the world's leader in public funding of agriculture, but beginning in about 2000, China began dramatically increasing its investment and has now surpassed

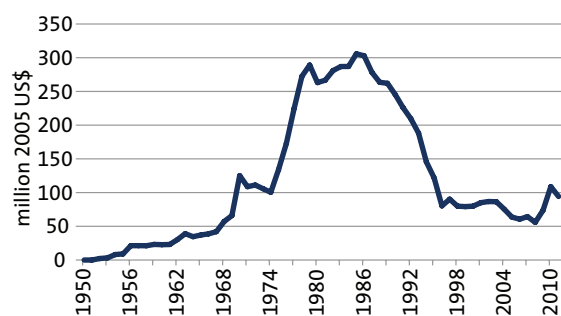
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the United States. In 1960 high-income countries accounted for 56 percent of the world's total agricultural research spending. Spending by middle-income countries, including Brazil, India, and China, now surpasses high-income countries.<sup>13</sup> Loss of leadership in this area puts the advances needed in the global food system at risk. Agricultural research capacity in developing countries, especially in Sub-Saharan Africa, is minimal, and international funding to the CGIAR consortium has diminished. Investments in public food and agricultural R&D need to be revitalized, and the United States is uniquely positioned to lead a global call for action.

### US investments in agricultural research, 1950–2010



Note: Data in US dollars deflated to 2005 prices with implicit GDP deflator from Bureau of Economic Analysis (2012).

Source: Adapted from Pardey and Beddow (2013).

## The United States should double investments in agricultural and food research over the next 10 years.

The United States needs to double investments in agricultural and food research over the next 10 years to help meet these challenges. Research funds should be focused on priorities that will be most important to meeting future demand: equipping agriculture both domestically and in low-income countries to be resilient to climate change and weather variability; aligning agricultural production and nutrition goals; and ensuring agricultural production builds rather than harms the natural resource base. Public agencies—such as USDA, the new Foundation for Food and Agricultural Research, and National Science Foundation—

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the US Congress, and research universities will be game-changing players in increasing the investment in agricultural research and reshaping national priorities. Given the lag time between the research funding and the eventual uptake of technologies, R&D investment decisions need to be taken with a long-term perspective and a funding horizon of at least a decade.

### Forge a new science of agriculture

Agriculture's mandate should be expanded beyond simply increasing production. Agriculture must increase production in a way that uses fewer resources and optimizes nutrition outcomes while providing solid incomes to food producers. Experts from all scientific disciplines are needed to increase nutritious food production sustainably. Proven approaches and innovations should be transferred to farmers everywhere, but especially to women and underproducing farmers in Sub-Saharan Africa and South Asia. A new multidisciplinary science of agriculture is needed and should be based on increasing outputs—production, nutrition, and incomes—while using less land and

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water resources.<sup>14</sup> This requires improving human health through accessible nutritious food, improving food safety, and reducing food waste along the supply chain. The US Congress should consider convening a

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### **Build research capacity**

Because the challenges facing the food system will be both global and local, international research institutions need increased support. At the same time, there is a need for transforming university and research institutions in developing countries so that they conduct the research that is critical to their location, context, and people. The US government has ramped up this type of training over the past five years, but it is nowhere near the level of support the US provided in the 1970s and '80s at the height of the Green Revolution.<sup>15</sup> These efforts should be expanded to develop local institutions in developing countries. This can be done through public-private partnerships, educational exchanges, and connecting universities around the world. The US university system is well positioned to contribute to this, but increased funding is needed to facilitate partnerships and educational exchanges between universities in the United States and institutions in the developing world.

### **Bolster research on climate change**

Climate change is already beginning to threaten the global food supply. Recent scientific reports predict that the hotter temperatures and natural disasters already undermining food production will be increasingly common. The effects from climate change are expected to slow the growth of food production by 2 percent each decade for the rest of this century.<sup>16</sup> The US government must increase funding for research to build resilience and address the threats to the food

system posed by climate change. In order to prepare for climate change, more research is needed on increasing tolerance to higher temperatures, building resilience to extreme weather events, and combating pests and diseases. While it's becoming increasingly clear that the consequences of climate change will be severe, there are significant gaps in the current understanding of the effects along the value chain, from farmers' fields to consumers. Better models are needed to help understand the effects of climate change. Food producers cannot prepare effectively and researchers and businesses cannot innovate without better data. Data on weather, water resources, crop performance, land use, and consumer preferences are necessary to adequately prepare. Better models and data are crucial for increasing productivity, enhancing nutrition, and increasing resilience to the effects of climate change.<sup>17</sup>

### **Expand nutrition-sensitive agricultural research**

Malnutrition—from undernourishment to obesity—is already affecting every country on earth and placing nearly one-half of the world's population at serious health risk.<sup>18</sup> Although nutrition interventions such as therapeutic foods to manage severe acute malnutrition and supplements to address micronutrient deficiencies are necessary, good health is driven largely by access to overall nutritious diets.<sup>19</sup> The US government should make nutrition a key priority in agricultural research to increase access to healthy foods, drive economic growth in poor countries, and improve the livelihoods of small-scale farmers. The current fruit and vegetable supply is far from sufficient for everyone to meet recommended nutrient intakes, especially in low-income countries. Research across the entire food value chain is critical in order to increase production; reduce costs; and improve the storage, processing, and transport of horticultural crops.<sup>20</sup> In addition, food safety is an often neglected but essential component at the nexus between nutrition and agriculture that requires additional research. Aflatoxin contamination is one of the most pressing food safety challenges in developing countries, affecting one-quarter of harvests worldwide.

### **Reduce food waste**

An estimated one-third of all food produced globally is wasted. In developed countries, consumers throw too much food away. In developing countries, food often rots before it can be processed or brought to market

because of poor infrastructure that allows pests and other contaminants to run rampant. Innovations in reducing food waste are desperately needed. Because fruits and vegetables as well as fish spoil more quickly and are more difficult to transport than grains, they are wasted in greater quantities—along with the valuable nutrients they contain.<sup>21</sup> In addition, the higher temperatures and humidity brought by climate change will cause even more food to be wasted without innovations in cold storage and transport. Finding innovative ways to reduce food waste and bringing them to scale would help meet the increasing demand for food without necessarily growing more food. Innovation from the private sector could help significantly in addressing this challenge.

## **US leadership is crucial for meeting the challenges to the global food system.**

As the rate of agricultural productivity growth continues to slow both in the US and globally, it is clear that a change in the global research enterprise is essential to meet the future challenge of feeding two billion more people by 2050. The United States is a global leader in agricultural research, holding almost 15 percent of the world's public agricultural knowledge stock. US leadership is crucial for revitalizing the research institutions and investments needed to increase productivity,

produce more nutritious food, use fewer resources, and adapt to climate change. Investing in agricultural research and taking a more comprehensive approach to utilizing existing knowledge would help safeguard the productivity gains made in the United States over the past century while meeting the future challenges facing the global food system.

## **About the author**

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