

Special Report

Feeding The World



INTRODUCTION



Feeding The World

There are hungry people everywhere. The situation is most dire in the developing world, where the population is slated to increase sharply by 2050, and where there is neither enough food to feed the rapidly growing population nor the infrastructure to store, transport and distribute what food there is. Dramatic urbanization further complicates the picture. The situation is very different in the U.S., which produces far more food than its relatively slow-growing population consumes, but still has millions of residents who don't know from day to day whether or not they will have enough to eat.

Common to hunger in both the developed and developing world are the twin scourges of poverty and, paradoxically, obesity (entrenched in the U.S., and rising fast just about everywhere else). But the specific challenges to feeding the hungry are different in the two regions, as are the most promising solutions.

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Globally, beating the scourge of hunger is made much more difficult by climate change, which leads to weather extremes, and water scarcity – already a major problem in both India and China. Other challenging issues include food waste, which eliminates 24% of the food calories produced for human consumption; global conflicts, which create refugees and reduce agricultural output; and changes in what people eat that favor resource-heavy meat production.

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The first Green Revolution dramatically increased crop yields and averted the famine that was predicted for the developing world in the 1960s. Experts say that the world needs to increase those yields by another 60% to 100% by 2050 to feed a population that could reach 9 billion. The key to reaching those targets may lie in some major technological advances from both government at all levels and private donors.

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There are 49 million people in the United States who lack access to healthy food. The obstacles they face are many – multiple jobs and family obligations leave them with little time to shop or cook, and food deserts – the absence of food stores in urban areas – make fast food all too convenient, while the high price of more nutritious foods makes them unaffordable. Numerous programs are trying to help solve one or more of these challenges, with varying degrees of success.

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Feeding the Developing World: Six Major Challenges

TODAY, ONE IN NINE OF THE WORLD'S 7.3 BILLION PEOPLE — more than 800 million men, women and children — don't get enough to eat, despite the fact that more than enough food is produced daily to feed everyone on Earth (at least based on calories).

Most of the world's hungry live in the developing regions of Asia and Sub-Saharan Africa, and many of them are children. Inadequate nutrition kills more than three million children under age 5 every year, and is responsible for 45% of all such global deaths. Worldwide, one in six kids (a total of about 100 million) is underweight.

And yet, according to the Chicago Council on Global Affairs' "Healthy Food for a Healthy World" report, 1.9 billion people globally are overweight and 600 million are obese. Thanks in large part to growing consumption of so-called empty calories, many of these people are also among those with inadequate nutrition. "There are a billion hungry people, and more than two billion who are overweight or obese," said Danielle Nierenberg, the president of the nonprofit Food Tank advisory group. "People can be overweight and also malnourished."

Some progress is being made, however. The United Nations Food and Agriculture Organization (FAO) reports a drop of 42% in the number of chronically hungry people in the developing world since 1990, although China alone accounts for the vast majority of this progress (the reduction would have been just 7% without China's contribution).

Making more progress on hunger means facing up to the following six challenges:

1. POPULATION GROWTH. The FAO notes that world population growth is slowing, but the U.N. still projects an additional 2.3 billion people by 2050, nearly all of them

in the developing world. Sub-Saharan Africa's population will grow by 114% in the period, and that of East and Southeast Asia by 13%. Accelerating urbanization means that 70% of the world's population will be living in cities by 2050 (up from 49% in 2009).

Estimates of how much more food will be needed to feed this growing population range from 60% (according to the ActionAid report, "Rising to the Challenge: Changing Course to Feed the World in 2050") to 100% (the estimate that Robert Fraley, chief technology officer at Monsanto, gave National Public Radio in a 2014 interview). The FAO projects that it will require "raising overall food production by some 70% between 2005-2007 and 2050." According to the agency, "Production in the developing countries would need to almost double." Specifically, "annual cereal production will need to rise to about three billion tons from 2.1 billion today and annual meat production will need to rise by over 200 million tons to reach 470 million tons."

Today, more than 800 million men, women and children don't get enough to eat.

The need to increase food production so dramatically in just 35 years is daunting, but Nierenberg points out that such a scenario "is based on a lot of assumptions," such as the conclusion that a growing middle class will demand more meat in their diets, and that educating girls and investing in family planning won't reduce actual population numbers. "If nothing changes we'll have to reach that 70% figure, but much can be done to change that scenario," she said. "Just reducing post-harvest losses through better storage

[cutting the tops off sweet potatoes before you store them, for example, or better silos and drying mats] could help reduce the 1.3 billion tons of food waste ever year.”

2. FOOD WASTE. Many experts say that enough food exists to feed 10 billion people today. Unfortunately, it’s not only inadequately distributed but also, to a large extent, wasted. “It’s terrible that farmers put so much labor and water into growing crops, but then can’t sell them because they rot before getting to market,” Food Tank’s Nierenberg said. “Food waste is the low-hanging fruit in the system.”

According to the World Resources Institute, “About 24% of all the calories produced for human consumption don’t actually end up reaching human mouths.” The group said that if that rate of loss could be cut in half, to 12%, the world would need about 1,314 trillion kilocalories (kcal) less food per year than in a business-as-usual scenario.

“Food is lost or wasted throughout the supply chain, from initial production down to final household consumption,” the FAO said. “The decrease may be accidental or intentional, but ultimately leads to less food available for all. This may be due to problems in harvesting, storage, packing, transport, infrastructure or market/price mechanisms, as well as institutional and legal frameworks.”

While more than half of all food waste (56%) occurs in the developed world, a 2014 report titled, “Feeding Cities: Food Security in a Rapidly Urbanizing World,” concludes that the most severe food losses occur in Asia, at five stages in the process — production, handling and storage, processing and packaging, distribution and market, and consumption. According to the authors, Eugénie L. Birch, co-director of the Penn Institute for Urban Research (IUR) and Alexander Keating, Penn IUR project director, more than 80% of all this waste occurs in just three stages — 24% in production, 24% in handling and storage and 35% in consumption. “In the west, it occurs on the plate,” Birch said in an interview. “In the developing world, the biggest problems are during production and the journey from the farm to the city. These are two different issues that have to be addressed.”

3. CLIMATE CHANGE. “Trying to understand the overall effect of climate change on our food supply can be difficult,” wrote the U.S. Environmental Protection Agency (EPA) in a report titled, “Climate Impacts on Agriculture and Food Supply;” based in part on 2008 reporting from the U.S. Climate Change Science program and others. The EPA points out that, ironically, increases in carbon dioxide can be beneficial to “some crops in some places,” but only if necessary conditions of nutrient levels, soil moisture

and water availability are met. “Changes in the frequency and severity of droughts and floods could pose challenges for farmers and ranchers.... Overall, climate change could make it more difficult to grow crops, raise animals and catch fish in the same ways and same places as we have done in the past.”

A 2014 paper by scientists at the Massachusetts Institute of Technology and Colorado State University, published in the journal *Nature*, concluded that climate change would reduce crop yields by more than 10% by 2050, “with a potential to substantially worsen global malnutrition in all scenarios considered.” The International Food Policy Research Institute (IFPRI) concluded in a 2009 report that an additional 25 million children would be malnourished by 2050 because of global warming’s negative effect on agriculture.

Rising temperatures are a key part of the problem. “It’s an unknown, but we do know that as temperatures rise, crop productivity declines,” said Alan M. Kelly, the Gilbert S. Kahn dean emeritus at the University of Pennsylvania School of Veterinary Medicine. A National Academies of Science report said that yields of corn, soybeans and cotton in the U.S. could drop dramatically because of many more days with temperatures above 86 degrees Fahrenheit. A further wild card is that both insects and crop diseases are likely to flourish with warmer temperatures.

Ozone levels are another part of the challenge posed by climate change. According to the *Nature* article, “Ozone trends either exacerbate or offset a substantial fraction of climate impacts depending on the scenario, suggesting the importance of air quality management in agricultural planning. Furthermore, we find that depending on the region, some crops are primarily sensitive to either ozone (for example, wheat) or heat (for example, maize) alone, providing a measure of relative benefits of climate adaptation versus ozone regulation for food security in different regions.”

All of these climate-induced changes will affect food prices, a critical consideration for the world’s poor. IFPRI agricultural economist Gerald Nelson told *Scientific American*, “Biological impacts on crop yields work through the economic system resulting in reduced production, higher crop and meat prices, and a reduction in cereal consumption. This reduction means reduced calorie intake and increased childhood malnutrition.” Without climate change, IFPRI reported that wheat prices could rise 39% by 2050 (from \$113 to \$158 per metric ton). Once global warming is factored in, the cost of wheat could rise at least 170%, to approximately \$190 per metric ton.

"If climate change were to retard economic development beyond the direct effects on agriculture in the poorer regions, especially in Africa [as a result of human health impacts or other factors], then overall impacts could be sizeable," noted the FAO study titled, "Global Climate Change and Agricultural Production: Direct and Indirect Effects." Relative agricultural productivity will shift to favor developed countries, it said, with direct impact on already skewed resource allocation.

4. WHAT PEOPLE EAT. The World Resources Institute projects livestock consumption in the U.S. and Canada could actually drop 2% between 2006 and 2050 (and climb just 7% in the European Union), but increase 46% in China and 94% in India.

Overall, the FAO report "World Livestock 2011" concludes that by 2050, average global consumption of meat protein will be 73% higher than in 2011. Dairy consumption is also on an upward trajectory, scheduled to grow 58% in the period.

A switch to meat-based diets, which are resource-intensive, has clear implications for agricultural productivity and feeding a growing world population. Much new meat production would come from the intensive systems common in the U.S., and FAO writes that such methods "are a concern because of potential environmental impacts, such as groundwater pollution and greenhouse gas emissions." The study adds, "An urgent challenge is to make intensive production more environmentally benign."

The primary driver of this increase in meat and dairy consumption is increasing wealth. FarmEcon LLC, an agricultural and food industry consulting firm, projects, "Production growth will be primarily driven by a near doubling of per capita GDP in constant dollar purchasing power. A more affluent world will, as it has in the past, want the variety and nutrition offered by more meat in the diet."

But Food Tank's Nierenberg suggests that this assumption is worth questioning. "The assumption is that the growing middle class in places such as China and India is going to eat more meat, but people could be convinced that industrially produced meat isn't the best bet for their future." Food Tank advocates for gradual steps, such as Meatless Mondays, and healthy steps such as increasing vegetables and fruit in the diet.

5. WATER RISK. "The water issue is more imminent than climate change," says Lester Brown, author of the forthcoming book *When the Wells Go Dry* and founder of both the Worldwatch Institute and the Earth Policy Institute. "We're overpumping our aquifers virtually

everywhere in the world to support the current population," he said. "The world is running up a vast water deficit."

In the book, Brown writes that the number of rivers in China dropped from 50,000 in 1950 to 23,000 in 2013. In India, he said, "Water tables are falling in every state. And aquifer depletion can shrink harvests, something we've seen in the Middle East. The grain harvest in Texas and Oklahoma has been affected in that way, and that's in part because those states are on the shallow, southern end of the Ogallala Aquifer." Asian Pacific Economic Cooperation's Human Resources Development Working Group reports that in the Texas High Plains, 10 times as much water is being pumped out of the aquifer than is being replaced by rainfall.

And *National Geographic* reported, "As drought worsens groundwater depletion, water supplies for people and farming shrink, and this scarcity can set the table for social unrest. Saudi Arabia, which a few decades ago began pumping deep underground aquifers to grow wheat in the desert, has since abandoned the plan, in order to conserve what groundwater supplies remain, relying instead on imported wheat to feed the people of this arid land."

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By 2025, 1.8 billion people are likely to be living in regions with absolute water scarcity, the United Nations reports — and Sub-Saharan Africa leads the world in the number of water-stressed countries in any region. By 2030, up to 250 million Africans will be living in areas of high water stress. Scarcity in arid and semi-arid places, mostly in the developing world, will affect — and displace — up to 700 million people.

According to the World Bank, a warmer world would leave about a billion people living in monsoon basins (and 500 million in deltas) "especially vulnerable" to water scarcity. The 2012 report, titled, "Turn Down the Heat," concludes, "Poorer countries, which contributed least to the problem, will be the most affected."

The Bank said that 70% of global water withdrawals are for agriculture, and that meeting the food needs of 9 billion people by 2050 will require a 15% increase in those withdrawals.

6. GLOBAL CONFLICT AND FOOD INSECURITY. Food insecurity is both a cause of civil conflict, and a result of it. According to “Food Insecurity and Global Conflict,” a 2011 report from the World Food Programme, “Rising food prices contribute to food insecurity, which is a clear and serious threat to human security.” In 2007 and 2008, food protests and riots occurred in 48 countries as a result of record high prices. In 2011, FAO reported a new peak for the food price index, with subsequent protests in North Africa and the Middle East (toppling two presidents).

The Global Food Report for 2014/2015 recounts the destroyed infrastructure in Gaza, Iraq, Nigeria, Syria, Yemen and other “conflicted-afflicted places” in 2014. And it concludes, “In addition to the humanitarian tragedies associated with these conflicts, the destruction of infrastructure, together with disruptions in access to

markets, often renders goods and services prohibitively expensive or makes them unavailable altogether. Both investors and tourists often abandon conflict-affected areas, and clashes between conflicting parties force millions of refugees to flee either to safer places within the affected countries or across the border to neighboring countries. As a result, economies often contract, instability and insecurity spill over national borders, and food and nutrition insecurity rises.”

The world faces substantial challenges in meeting the food and water needs of 2050, when global population could be 9 billion or more. Initiatives to address our future needs are critical, and they will have to take into account the complicated interplay of a variety of stressors on the world agriculture system.





Feeding the Developing World: The Search for Solutions

DIRE PREDICTIONS HALF A CENTURY AGO of a world unable to feed a population explosion did not come to pass, largely due to the “Green Revolution” that used innovative techniques to dramatically increase crop yields. But will there be a second Green Revolution, one that is more sustainable, to feed the next leg of population growth, mainly coming from developing nations?

A recent study by the DuPont Advisory Committee on Agricultural Innovation and Productivity for the 21st Century said that the current trajectory of population growth vis-à-vis consumption of food is not sustainable. The report is projecting a 23% increase in the global population to more than 9 billion by 2050, with nearly all the growth coming from the developing world where agricultural productivity is relatively low, such as sub-Saharan Africa and Asia. “Global food production must be 70% greater than today’s level to close the deficit between supply and demand,” the study said. This is a “productivity gap” that must be closed “without using substantially more land.”

The first Green Revolution used hybrid seeds, modern crop management and chemical fertilizers and pesticides to save millions of lives. But the World Resources Institute said it came at a cost: Agriculture has become the “dominant driver” of tropical deforestation, accounts for 70% of all freshwater withdrawals from rivers, lakes and aquifers and emits much of world’s greenhouse gases (24% in 2010). “The world needs to reduce agriculture’s impact on the environment,” says Gary Gardner, a senior fellow at the institute.

But there is cause for guarded optimism. The United Nations Food and Agriculture Organization cited opportunities to engender “agro-ecologically attained”

yields. “All in all, the potential to raise crop yields to feed a growing world population seems to be considerable,” the group said.

REDUCING PESTICIDE, FERTILIZER USE

One method that is more environmentally friendly is to treat seeds with herbicides and pesticides rather than waiting for them to grow into mature plants. The plants that come from treated seeds already incorporate these chemicals, making large-scale broadcasting of the compounds unnecessary. And since the chemicals are embedded in the plant itself, not the surrounding soil, there is virtually no risk of runoff polluting nearby rivers and streams. It is not a perfect solution, because some pests on maturing plants will not be affected by seed treatments and can decimate crops. But “seed treatment is one of the fastest-growing parts of agriculture,” says Duncan Aust, global innovation director of FMC Corporation’s Agricultural Solutions.

Global food production must be 70% greater than today’s level to close the deficit between supply and demand.

Integrated Pest Management is a science-based approach that takes into account the large body of literature on the lifecycles of individual insects. Here, farmers can accurately identify the pests that have attacked their crops, set threshold infestation levels for taking action with pesticides, use rotation and other prevention methods, then use carefully targeted spraying of approved, low-impact chemicals.

Another, holistic, approach is precision farming — combining the use of satellites, smart sensors and sophisticated IT systems to limit the application of agricultural chemicals, water and other resources to just those areas where they are needed. Launched in the 1980s, the practice is now so prevalent that the European Agricultural Machinery Association estimates that 70% to 80% of new farm equipment sold today includes precision farming components.

Satellites provide location-specific information about terrain, vegetation, water and weather. Sensors precisely monitor soil moisture in farm fields and eventually collect data on both nutrient content and soil temperature. Computer programs ingest data from all these sources and instruct farmers, and often farm equipment, about exactly where and when to place which resources, and exactly how much of each is needed. “Anything in excess of what’s needed, doesn’t help the yield,” said Ratnesh Kumar, who works with these sensors along with his research team at Iowa State University. “Those resources just drain into the environment.”

There are some 500 million smallholder farms across the globe, many of which are marginally productive.

“Biologicals,” or products derived from living organisms, offer yet another fast-growing approach to sustainably increasing agricultural productivity. There are three categories of biologicals: bio-pesticides (including bio-herbicides, bio-insecticides and bio-fungicides), bio-stimulants, and bio-fertilizers. FMC’s Aust said that the company is developing microbial bio-stimulants that can be applied to crops grown in arid regions to dramatically improve their resistance to drought without genetic engineering of the plants. “You could see 5% to 100% yield increases, and also enhance drought tolerance,” he says. And crops grown with biologicals generally qualify as organically grown, according to trade publication *Agra Europe*.

As in the past, hybridization holds a great deal of promise. Aust says scientists are now developing higher-yielding, more nutritious crop strains that are resistant to pests and disease and able to tolerate drought, extreme heat or both — all conditions that climate change is making increasingly common. New approaches to hybridization allow this work to proceed much faster than it did during the first Green

Revolution. For example, the marker-assisted breeding program at the Donald Danforth Plant Science Center in Missouri uses DNA sequencing to radically accelerate the otherwise time-intensive and laborious process of breeding new plant varieties.

More common and better known to the general public is genetic engineering, a technique that involves physically manipulating the genome of plants, which is practiced by Monsanto and others. In addition to enabling the creation of hybrids that can thrive in specific environments, genetic engineering has allowed companies to create crops that are resistant to pesticides and herbicides, making the targeted use of these chemicals far more effective, says Aust.

To be sure, genetic engineering has critics, such as the Union of Concerned Scientists, which favors “crop breeding (often assisted by molecular biology techniques) and agroecological practices such as crop rotation, cover crops, and integrated crop and livestock management,” as well as increasing yields by widening access to water and fertilizer. But John Kasper, FMC’s commercial director for North America, says that opposition to genetically modified crops can be counter-productive because such strains will be needed by developing countries as their climates change in the near future.

Genetic engineering is also being used to boost photosynthesis. According to a 2015 study in *Cell* magazine, “photosynthesis, which has been improved little in crops and falls far short of its biological limit, emerges as the key remaining route to increase the genetic yield potential of our major crops. Thus, there is a timely need to accelerate our understanding of the photosynthetic process in crops to allow informed and guided improvements via in-silico-assisted genetic engineering,” referring to the use of computer modeling or simulations. Furthermore, Kevin Bonham, a curriculum fellow in the microbiology and Immunobiology department at Harvard Medical School, wrote in *Scientific American* that “increasing yield through photosynthesis would allow us to grow more food on less land,” and thus feed a growing global population.

INNOVATION AND PRODUCTIVITY

Producing meat is extremely resource-intensive and the demand for meat is growing rapidly in parts of the developing world, most significantly in China. But what if we could produce meat without having to raise animals? Andras Forgacs, bio-printing entrepreneur, has started a company to 3D print in vitro meat. “This is biofabrication, where cells themselves can be used to grow biological products like tissues and organs,” he said during a

2013 TED Talks appearance. He pointed out that such techniques have already been used in medicine to grow such body parts as ears, blood vessels and bone. “Beyond medicine, bio-fabrication can be a humane, sustainable and scalable new industry,” he said. During his talk, Forgas displayed some cultured leather, which he said is the first step toward producing meat and other animal products in the laboratory.

Added FMC’s Aust: “Biofabrication would involve a lot less resource inputs, produce less carbon dioxide, and require fewer applications of herbicide.” Research is key to developing innovative solutions such as biofabrication, precision farming and biologicals. “As we continue to invest in agricultural research and technology we will have continued innovation, and that will enable increased output, including in the developing world,” says FMC’s Kasper.

But persuading governments to fund agricultural research remains a challenge. “Over time, private investments in agricultural innovation have steadily increased, while public investments have stagnated or declined, according to the 2013 report, “Feeding the Planet in a Warming World,” jointly published by the London School of Economics and Political Science and the Information Technology and Innovation Foundation. “Governments, transnational institutions and nonprofits need to reverse this trend.” It urged the U.S. Congress to triple its investment in agricultural research and development from \$5 billion to \$15 billion per year. The researchers also called for reductions in regulations “applied to crops improved through biotechnology.”

Much of this research will foster the growth of big agriculture, which FMC’s Kasper sees as essential. The consolidation of farms into larger business units increases productivity, he says, “and like it or not, the movement to bigger and more efficient units is essential, especially as more people leave farms for the city.” Indeed, the urbanization trend is accelerating. In 1900, 13% of the world’s population lived in cities. By 1950, it was 29%, and by 2030 it is projected to reach 60% — or nearly 5 billion people. According to “Food Security: Feeding the World in 2050,” a 2010 Royal Society Publishing report, “it is likely that the proportion of the global population not producing food will continue to grow, as will the number of middle- and upper-income consumers whose dietary choices are more energy- and greenhouse gas emission-intensive.”

ROOM FOR SMALL-SCALE GROWERS

Small-subsistence farmers also need to be part of the second Green Revolution: “If you care about the poorest,

you care about agriculture,” said Bill Gates in his role as co-chair of the Bill & Melinda Gates Foundation. “Investments in agriculture are the best weapons against hunger and poverty, and they have made life better for billions of people. The international agriculture community needs to be more innovative, coordinated, and focused to help poor farmers grow more. If we can do that, we can dramatically reduce suffering and build self-sufficiency.”

Gates added that “when Melinda and I started our foundation more than a decade ago, we initially focused on inequities in global health. But as we spent more time learning about the diseases of poverty, we realized that many of the poorest people in the world were small farmers. The conclusion was obvious. They could lift their families up by growing more food.”

To keep moving in the right direction, both the public and private sectors will have to ramp up their investment in research and other projects that spur innovation and efficiency.

There are some 500 million smallholder farms across the globe, many of which are marginally productive. Their output — and thus the world’s food supply — would increase dramatically if they joined the second Green Revolution. The first Green Revolution nearly doubled real per capita income in Asia between 1970 and 1995, and regional poverty dropped from 60% to less than 33%. Expecting similarly dramatic results this time around might be somewhat optimistic, but the promise remains great.

To accomplish substantial gains, the developing world’s smallholder farmers need access to tools such as “modern irrigation practices, crop management products, fertilizers, post-harvest loss solutions, improved seeds, mobile technology, as well as access to information and extension services,” the DuPont committee concluded. Add to this solutions to large-scale spoilage, which results from both lack of refrigeration and poor transportation networks.

The fact that smallholders generally lack such access through international aid is why Gates has called for UN food agencies to better coordinate their assistance efforts. He urged the FAO, the International Fund for Agricultural Development and the World Food Programme to “create a global productivity target for small farmers — and a system of public scorecards to measure how countries, food

agencies, and donors are contributing toward the overall goal of reducing poverty.”

Gordon Conway, professor of international development at Imperial College London, director of Agriculture for Impact, and former president of the Rockefeller Foundation, told an audience at the World Bank that small farmers also need to be able to sell what they grow, and national networks of markets and village-level “agrodealers” can better connect growers with the markets that need their crops while also improving the farmers’ access to supplies and information. In addition, local producer associations, some encouraged by governments, can help farmers get fair prices for their output.

As with high-tech innovation, such progress requires investments. The FAO said investments in primary agriculture “should become a top priority” and increase by 60%, not only to produce enough food for a growing world population but also to generate income to get people out of poverty and support rural livelihoods.

In 2012, the World Bank Group increased its agriculture investments to \$9 billion, more than 90% of which was earmarked for “improving farm-level productivity and market access, especially for smallholder farmers.” Both the public and private sectors have been joining these efforts. “Partners in Food Solutions” unites Cargill, General Mills and Royal DSM in an effort supported by U.S. Aid for International Development (USAID) to improve the food value chain in Africa. Its tools, which include web-based and onsite training, are aimed at improving crop quality and shelf life, educating farmers about business plans and financial strategies, and gaining cost savings through lower-cost raw materials and packaging.

Other corporations have also gotten involved in this work through their charitable arms. The Wal-Mart Foundation, for instance, recently invested \$1 million in a program with USAID in Rwanda. The Ejo Heza (A Brighter Future) campaign champions adult literacy and nutrition education, expanding agricultural production and access to financial resources. The Nestlé Cocoa Plan, announced in 2013, is

financing farmer field schools aimed at improving farming practices and yields. Some 45,800 farmers were trained in 2014, and Nestlé said it is on track to offer 12 million higher-yielding cocoa plants to farmers by 2019. The Gates Foundation, too, is contributing. In a recent \$200 million funding round, it provided \$21 million to develop drought-, disease- and insect-resistant legume strains for India, Bangladesh and 13 countries in Africa. Many of its grants focused on sub-Saharan Africa, including \$33 million for drought-tolerant maize that could improve yields for seven million African farm families.

MEASURED PROGRESS

Food security is slowly improving overall in sub-Saharan Africa and in other developing parts of the world. According to The Economist Intelligence Unit’s 2015 Global Food Security Index, sponsored by DuPont, two thirds of the 109 countries studied made progress from a year earlier. The average score on the index rose 1.2 points. “Driving the gains were sustained economic expansion in most regions and rapid growth in developing countries (especially in sub-Saharan Africa) combined with lower global food prices,” the report noted. Of the 28 countries in sub-Saharan Africa, 82% saw food security increases between 2014 and 2015, and the region as a whole increased 1.5 points. The most improved countries expanded their ability to store crops, lowered their post-harvest, pre-consumer food loss, and increased diet diversity.

Since 2011, “the world has made some progress toward eradicating extreme hunger and poverty. During this time, developing countries have managed to reach the point of nearly halving the proportion of those suffering from hunger,” added a 2014 report from the DuPont Advisory Committee.

To keep moving in the right direction, both the public and private sectors will have to ramp up their investment in research and other projects that spur innovation and efficiency, both for big agriculture and for the small farmers of the world. If that happens, the prospects for feeding a world population of 9 billion would be much improved.





The Struggle to Feed America

HUNGER IN THIS COUNTRY IS NOT THE RESULT OF SCARCITY. The United States exports more agricultural products than it imports (a record \$152.5 billion in 2014), and domestically sells 30% more than consumers actually use (that's how much is wasted each year — \$162 billion worth of food that goes uneaten).

And yet, amidst all this plenty, 49 million Americans, about one in six, meets the U.S. Department of Agriculture's (USDA) definition of food insecurity. The explanation of this paradox is as obvious as it is disheartening: "In so many ways, hunger is a synonym for poverty," says Domenic Vitiello, a professor of city planning and urban studies at the University of Pennsylvania. But understanding the cause does little to solve the problem. The battle against poverty may have gained some ground in the past few decades, but virtually no one believes we're likely to win the war anytime soon.

So the immediate and urgent question is, what can be done to reduce hunger in the U.S. now?

The most obvious approach is to simply provide hungry people with food. That's what food banks have been doing since 1967, when the first one was started in Arizona. Today Feeding America, the nation's largest domestic hunger-relief organization, has a nationwide network of 200 food banks, large warehouses that distribute food to 60,000 food pantries and meal programs, which in turn package the food for local distribution to the poor. While this network alone provides three billion meals a year, the full impact of the nation's food bank system is hard to determine. Feeding America represents only the largest programs. In fact, says Vitiello, "Small food banks are not allowed to be members of Feeding America at this point."

One major source of public support for food banks is The Emergency Food Assistance Program (TEFAP), which

both reimburses food banks for administrative costs and provides them with food. TEFAP's larder is stocked by the USDA, which purchases surplus food from the companies that produce it. The original program began during the Great Depression in the 1930s as a way of helping both consumers who couldn't afford to buy enough food, and farmers who couldn't sell enough to survive. Today, however, when the USDA "pays big food companies for their surplus," Vitiello says, it's "usually for their mistakes, either over-production or very commonly mistakes in package labeling or other small production mishaps."

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Since much of what the food industry produces, markets and sells is highly processed "energy-dense" products, much of the surplus the sector sells to TEFAP is high in calories and low in nutrition. And because food banks generally lack bulk refrigeration and processing kitchens, very little of the food they stock includes fresh produce, meat and dairy. The result is predictable. According to "Nutrition-Focused Food Banking," a 2015 report by the National Academy of Sciences (NAS), "Increased concerns about obesity and chronic diseases, particularly among the poor, have led to questions about the nutritional quality and calorie density of foods on the shelves of food banks."

This concern has started changing the way the system operates. According to the NAS report, food banks are increasingly working to distribute healthier food. Feeding

America is supporting their efforts by providing nutritional guidance, “with the aim of helping food banks to identify and source healthful foods.”

This proactive approach is a significant departure from the way the system used to work. “Historically, food banks have been all about taking whatever food is offered and finding a way to feed people with it,” says Melanie Cataldi, senior vice president and chief operating officer of Philabundance, the largest hunger-relief organization in and around Philadelphia. “I think a lot of food banks are now moving in the other direction, trying to figure out what the community needs and finding a way to get that.”

For Philabundance, one of the best ways is through contributions from companies using the nearby port of Philadelphia. For many others, “gleaning — gathering food left over after harvesting — is the most productive way to get fresh food inexpensively, “particularly where food banks are connected to big agriculture,” says Vitiello. In some areas, smaller food banks are connecting to local farms and even starting their own farms. They are also accepting donations from deer hunters and, in certain areas, from commercial meat producers, who have started making significant donations. The Texas Cattle Feeders Association, for example, provided 4,000 pounds of beef to the High Plains Food Bank in 2014.

The challenge, of course, is that all of this nutritious food is perishable, which is why a growing number of food banks are developing the capacity to refrigerate and/or preserve it. Given its long-time access to fresh food from the port, Philabundance has had refrigeration for some time, but about six years ago, the growing emphasis on healthy food led the organization to refrigerate an entire warehouse and to raise funds so that it can provide member agencies with refrigeration.

MAKING HEALTHY FOOD ACCESSIBLE.

As important as they are, food banks are a secondary safety net, according to Bill Clark, former executive director of Philabundance and now a visiting practitioner at Wharton’s Social Impact Initiative. Speaking at a University of Pennsylvania conference on urbanization and food security, Clark noted that the federal Supplemental Nutrition Assistance Program (SNAP) provides 10 times more assistance to Philadelphia’s poor than Philabundance does.

SNAP, WIC (Women and Infant Children) and other programs that provide financial assistance don’t feed people directly — they make it more affordable to buy food. But SNAP assistance (still generally known as food stamps) is of little use if a recipient has nowhere to use it.

In many inner-city neighborhoods, there is no supermarket or grocery store available. “These communities may have no food access or are served only by fast-food restaurants and convenience stores that offer few healthy, affordable food options,” according to the USDA.

Chester, Pa. was a prime example of such a “food desert.” In 2012, the town’s estimated per capita income was about \$15,000 and the last operating supermarket had shut its doors 11 years before. As Clark noted, “food deserts also become ‘charitable deserts,’ so in September 2013, instead of a typical food bank operation, Philabundance opened a small non-profit supermarket in Chester. The hope, according to Clark, was to use charitable and government funding for start-up capital, but to eventually earn enough to make the market self-sustaining and scalable. “Part of what we are trying to do is to learn from this process and template this store so we can duplicate it in other needy food deserts,” said Clark.

FALLING SHORT

In its first year and a half of operation, the store, called Fare and Square, has not met the group’s expectations for memberships or sales, in part because Philabundance didn’t know at first what kinds of food would be most appealing to local residents or how to efficiently operate a working grocery store. But the group is learning fast both from experience and from ongoing market research.

Philabundance has also modified its approach. The goal is no longer to create a totally self-sustaining operation, but to use store revenues to reduce dependence on charitable donations and keep prices as low as possible. It’s early days yet, but the store’s prospects are brightening. A more neighborhood-oriented product mix is lifting sales, improved operating efficiencies are reducing costs, and donors stand ready to help make up any shortfall.

Non-profit markets like Fare and Square are rare, though Doug Rauch, a former president of Trader Joe’s, recently opened one in Boston. More common in former food deserts are for-profit supermarkets created by public-private partnerships involving various levels of government, philanthropists and private developers. Benjamin Chrisinger, whose Ph.D. dissertation at the University of Pennsylvania studied these markets, said that about 100 stores have opened in food deserts, and so far only a handful have closed.

Chrisinger’s research reinforces what Philabundance learned about the importance of product selection. “If you don’t have the right price points or the types of food people want to buy, then people may shop there, but they

won't be the low to moderate-income people you were hoping to help," he says. It's a myth that people living in food deserts shop exclusively at corner stores. "They go to the supermarket for bigger shopping trips; it's just more challenging for them to get there," notes Chrisinger, since they have to drive further, if they have access to a car, or take public transportation. "So when you open a supermarket in a food desert you're really asking people to change where they're shopping." And convenience alone is generally not enough to motivate them.

And even if local people do shop at these stores, there is mounting evidence that the impact on their health is minimal. A recent New York Times article, "Giving the Poor Easy Access to Healthy Food Doesn't Mean They'll Buy It," points out that convenience alone is not enough to change people's habits. "It seems intuitive that a lack of nearby healthy food can contribute to a poor diet. But merely adding a grocery store to a poor neighborhood, it appears, doesn't make a very big difference." The article was based in part on a research paper by Wharton real estate professor Jessie Handbury titled "What Drives Nutritional Disparities? Retail Access and Food Purchases Across the Socioeconomic Spectrum."

According to Barry Popkin, a professor of nutrition at the University of North Carolina, "when we put supermarkets in poor neighborhoods, people are buying the same food [that they would have bought at corner stores]. They just get it cheaper." Why this is so is still being researched, but it seems clear that some combination of financial and social forces is at work. And education is key. According to a study published by the National Bureau of Economic Research, "Even in the same store, more educated households purchase more healthful foods."

GROW YOUR OWN

No one expects either community gardening or urban farming (the latter involves selling at least some of what is grown) to achieve the kind of scale needed to feed the nation's poor. And it's naïve to underestimate the challenges confronting such efforts. "Most poor people in the United States, who are of working age, are working," often at several jobs, so they don't have time to devote to gardening, says Vitiello. That's why it's generally older, retired residents who tend the gardens. And access to suitable land is rare. Know-how is yet another obstacle.

But Vitiello believes that by connecting community gardeners to local stores, food pantries and soup kitchens, small creative food banks and other programs "create relationships of mutual support that aren't often cultivated by the big warehouse and its large-scale distribution

system." While the benefits are hard to quantify, he admits, these relationships empower people to meet their own food needs. "A common critique of the traditional food-bank system is that it doesn't build anyone's capacity, including poor people's capacity to meet their own food needs," notes Vitiello, "Whereas, these smaller scale relationships often do."

THE RIGHT APPETITE

Urban farming, access to healthy food, education and direct food assistance — all are needed in the struggle against hunger, observers say. And some programs are working to bring them all together.

One such effort is Common Ground in New Haven, Connecticut, a high school, urban farm and environmental education center rolled into one. According to Common Ground principal Liz Cox, "A key part of our work is about creating an appetite for healthy food among students and within the New Haven community." That's why Common Ground students don't just learn about healthy lifestyles in class, they also share what they learn in school with their families, both informally and through formal school presentations.

And since an appetite for healthier food is of little use without access to such food, says Joel Tolman, the organization's director of impact and engagement, Common Ground has also started a farm food share program that provides families of students with fresh produce from the school's own farm and other nearby farms. To help parents make good use of the food, Common Ground offers cooking classes for families in the school's teaching kitchen.

Students are involved in all these efforts: working on the school's farm; helping out at farmers markets and with a mobile market that brings fresh produce to key locations throughout the neighborhood; doing market research to find out what kinds of food people want, and even organizing community meetings to address local issues.

In class, students learn about sustainable living and the root causes of hunger, as well as all the regular Common Core subjects, so that graduates can become what Cox calls, "a new generation of leaders." It's too soon to know how successful this strategy will be, but with more than 90% of students graduating and 93% to 97% getting into college, there's reason to hope that Common Ground graduates will be among those leading the way in the future.

Common Ground is by no means the only program taking a multifaceted approach to the problem of hunger in this country. The school itself partners with other key groups in

the city, including City Seed, a statewide effort to promote local food for local people, community development and sustainable agriculture. And other creative efforts — including food banks in California, Arizona, Michigan and

North Carolina, says Vitiello — are developing their own innovative approaches. Together with existing larger-scale programs, these localized efforts represent a hopeful path forward.



Special Report

Feeding The World

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