OUR DAILY BREAD

Without public investment, the food crisis will only get worse

Rosamond Naylor and Walter Falcon

What we are witnessing is not a natural disaster—a silent tsunami or a perfect storm . . . . [The food crisis] is a man-made catastrophe, and as such must be fixed by people.

–Robert Zoellick, The World Bank (July 1, 2008)

During the eighteen months after January 2007, cereal prices doubled, setting off a world food crisis. In the United States, rising food prices have been a pocketbook annoyance. Most Americans can opt to buy lower-priced sources of calories and proteins and eat out less frequently. But for nearly half of the world's population—the 2.5 billion people who live on less than $2 per day—rising costs mean fewer meals, smaller portions, stunted children, and higher infant mortality rates. The price explosion has produced, in short, a crisis of *food security*, defined by the Food and Agriculture Organization (FAO) as the physical and economic access to the food necessary for a healthy and productive life. And it has meant a sharp setback to decades-long efforts to reduce poverty in poor countries.

The current situation is quite unlike the food crises of 1966 and 1973. It is not the result of a significant drop in food supply caused by bad weather, pests, or policy changes in the former Soviet Union. Rather, it is fundamentally a demand-driven story of "success." Rising incomes, especially in China, India, Indonesia, and Brazil, have increased demand for diversified diets that include more meat and vegetable oils. Against this background of growing income and demand, increased global consumption of biofuels and the American and European quest for energy self-sufficiency have added further strains to the agricultural system. At the same time, neglected investments in productivity-improving agricultural technology—along with a weak U.S. dollar, excessive speculation, and misguided government policies in both developed and developing countries—have exacerbated the situation. Climate change also looms ominously over the entire global food system.

In short, an array of agricultural, economic, and political connections among commodities and across nations are now working together to the detriment of the world's food-insecure people.

A woman weeds a field with her child on her back at an irrigation project in Karonga, Malawi.

Cereals form the core of the global food system. In 2007 the world produced a record 2,100 million metric tons of grain. Most of these cereals were consumed in the countries in which they were produced. Some 260 million metric tons, or about 15 percent of production, were traded internationally. Food aid was about 6 million metric tons, about 0.3 percent of production. Although only 15 percent of production is traded in global markets, conditions in those markets have a large direct and indirect impact on cereal prices and demand in every country.

World grain production was exceptionally strong in 2007, and had actually grown in five of the eight years prior to 2007. Despite this success, demand exceeded supply in six of those years. This excess demand was met by drawing down global reserves. When, in 2007, the reserve-to-usage ratio dropped to a near-historic low, buyers and sellers reacted in ways that rapidly pushed up prices. Nonetheless, the current crisis of food security is not a result of some *absolute* shortage of basic staples. If all the cereals grown in 2007 had magically been spread equally among earth's 6.6 billion persons *and used directly as food,* there would have been no crisis. Cereals alone could have supplied everyone with the required amounts of calories and proteins, with about 30 percent left over. (Children would have also needed some concentrated calories and proteins, because of the bulkiness of cereals and their inability to consume sufficient quantities of them.)

Of course, food is not distributed evenly across the globe. Average income levels as well as income inequalities vary by country and are major determinants of access to food. And because cereals and oilseeds can be used in multiple ways, not only for food, competition for these commodities spans many different firms and households. These pressures on supply and price are powerfully exemplified by the case of corn, whose price dramatically affects the broader structure of global food markets.

Corn is quintessentially American. It is the country's largest crop in terms of area: in 2007, 94 million acres produced a record 330 million metric tons of grain. How is it possible that a record U.S. corn crop was centrally involved with the current high food prices? The answer lies mostly in corn's versatility. It provides about half of the 18 million metric tons of sweeteners that Americans consume annually, much of it in the ninety-six gallons of beer and soda they drink per capita. Some 46 percent of the crop went to feed livestock to produce the 270 pounds of pork, poultry, and beef the average American consumed in 2007, and about 19 percent went for exports. Ethanol, which had taken only a tiny fraction of corn output a few years earlier, took a full 25 percent.

A world with oil at $125 per barrel, gasoline at $4 per gallon, and corn at $6 per bushel (fifty-six pounds) seemed unthinkable five years ago. A new constellation of market forces has drastically altered price levels and the correlations among them. In particular, the enormous growth in the use of corn for fuel now links corn and gasoline prices in profoundly important ways.

The current corn-petroleum price connections in the United States arguably can be traced to the 2005 environmental regulations to eliminate methyl tertiary butyl ether (MTBE) as a gasoline additive because of environmental and health risks. Corn-based ethanol has since become the preferred additive, offering the same octane ratings and beneficial properties as MTBE. Ethanol is typically used in the form of a 10/90 mixture with gasoline, and consumers pay for this ethanol as they fill their cars with fuel at the pump. As gas prices rise, so does the potential value of corn ethanol. Most of the ethanol now produced—some 6.5 billion gallons from the 139 plants in operation in 2007—was used as an oxygenate for the 142 billion gallons of fuel used by Americans last year.

The sudden burst in demand explains the rapid increase in the portion of the corn crop being used for fuel. That demand might be expected to level off, as the market for additives will largely be supplied by 2009. But the United States is now poised on the brink of a second phase of ethanol use.

Ethanol can also be used in place of gasoline, even though it provides only about two-thirds the energy of gasoline on a volume basis. In other words, rational consumers would pay about 65 percent of the price of gasoline for their ethanol, since their cars would go about 65 percent

as far on a tank of fuel. Because ethanol must be shipped and stored separately, only with substantial new infrastructure could ethanol be a large-scale choice for fuel. And cars would require so-called "flex" technology to use fuel containing high percentages of ethanol.

Whether more than 25 percent of the corn crop is used for fuel in the future is critically dependent on the price of oil and also on the politics of biofuels. The latter include mandatory minimum levels of ethanol production and the explicit and implicit subsidies contained in various pieces of agricultural and energy legislation. Senators McCain and Obama both expressed strong support for ethanol in the politically important Iowa caucuses.

The ethanol-production mandate for 2008 is 9 billion gallons. That number will grow to 15 billion gallons in 2015 and 36 billion (total renewables) in 2022. Rescinding these increased mandates would likely stabilize demand for corn-based ethanol. (High enough oil prices, coupled with low enough corn prices could, of course, make ethanol economical even at 65 percent of the efficiency of gasoline.) But if the higher mandates are indeed imposed, then an increasing portion of the U.S. corn crop will be fed to cars, rather than to animals or people. Consumers of corn tortillas in poor countries will find themselves increasingly in competition with S.U.V. owners in rich countries. At the margins that matter, corn prices would be linked to gasoline prices, and the entire price structure for cereals would adjust accordingly.

In addition to mandates, current legislation also provides for credits (subsidy) of $0.51 per gallon to blenders and a $0.54 per gallon tax on imported ethanol plus a 2.5 percent additional duty on its value. Thus, in the United States, the economics of ethanol are fundamentally linked to specific legislative provisions. And what Congress has given, Congress can also take away.

Whether the mandates should be waived, the tariff on imported ethanol dropped, and the blender credits modified are all matters of intense debate. Corn farmers and investors in some 200 bio-refineries (on-line or under construction) are pushing for higher mandates; others believe that corn-based ethanol, however well-intended, is the wrong way to promote U.S. energy independence because of ethanol's effect on food prices. The stakes are huge. The United States is by far the largest corn exporter in the world. Further reductions in exports resulting from greater ethanol use would greatly amplify price instability in corn and other global food markets.

Many technical experts have argued that corn is not the appropriatecommodity for use in biofuels. However, industrial-scale production from sources other than corn (and sugar) is as yet unproven. Although the chemistry for alternative feedstocks has been developed, credit-worthy business plans, including supply chains, have not. Proponents of other crops tend to overlook the extensive experience the corn industry has had with enzyme technologies that derive from its twenty-five-year history making corn sweeteners. As a consequence, and for better or worse, larger biofuel mandates mean a corn-dominated ethanol industry for at least the next five years, accompanied by the inevitable price pressures on food.

An additional oil-corn connection is also important for farmers. The high oil prices that help drive the demand for biofuels also raise the energy costs of growing corn. Corn prices that have risen from less than $3 per bushel in 2005 to over $7 per bushel in 2008 have been a boon to farmers. Yet farmers (sometimes on their way to the bank!) are quick to point out that high oil prices are strongly and negatively affecting their businesses. Iowa State University maintains farm records that indicate the total cost for growing an acre of corn was $450 in 2005. By 2008, these costs had risen to more than $600 per acre. Seed and chemical costs have accelerated sharply and now constitute some 45 percent of total costs, including land-rental charges. Nonetheless, with rising yields and corn prices that have more than doubled, corn-based farm enterprises seem clearly better off in 2008 than in 2005.

Ethanol, then, is the beginning of the corn story, but far from the end of it. Corn's other linkages to soybeans, wheat, and meat illustrate why it is the keystone in the food system. Midwestern farmers produced the record corn crop in 2007 in anticipation of high prices. But the focus on corn implied a series of acreage decisions that reverberated around the world. The more than 15-million-acre increase in corn planting came mainly at the expense of soybeans, which saw a decline of twelve million acres, or 16 percent of total soybean acreage. The United States consequently played a reduced role as a soybean exporter. Brazil, another major exporter, picked up some of the slack. Nonetheless the world's production of soybeans declined in 2007 while three of the four largest countries in the world—China, India, and Indonesia—registered very strong economic growth. China imported an incredible 34 million metric tons of soybeans (45 percent of total world trade), which it used to produce soybean meal for some of its 600 million pigs and its large and rapidly growing poultry and farmed-fish sectors and also vegetable oil for its expanding urban population. In India and Indonesia, oilseed demand was driven less by livestock-feed requirements and much more by human demand for vegetable oils. India, for example, is one of the world's largest users and importers of cooking oils.

The tightened supply of vegetable oils and the accelerated Asian demand for oilseed crops—soybeans, rapeseed, and palm oil—explain some of the price increases. For example, during the period July 2006 to June 2008, oil palm prices tripled. But as with corn, the use of oilseed crops in the production of fuel—about 7 percent of global vegetable oil production went to biodiesel—was another significant factor. Most of the latter was driven by biodiesel policies in Europe, using rapeseed (canola) as the main feedstock.

Prospects for lowered vegetable oil prices in the short run, like those for corn, are not obvious. U.S. farmers rebalanced their plantings in 2008, in part because of a late spring and in part because soybean prices had risen to $13 per bushel, making it again an economically attractive crop for farmers. Brazil continues to expand soybean acreage in several states as well, but, interestingly, the most likely sources of greatly increased vegetable oil supplies will come from Indonesia and Malaysia. Palm oil has long been among the cheapest sources of vegetable oil, and Indonesia has been planning a major expansion of area devoted to oil palm production. This expansion is complicated, however, by the potentially high environmental costs of clearing tropical forests, and because palm trees take up to three years before they yield economical harvests. Indonesia had originally planned the oil-palm expansion for biodiesel production for European and domestic fleets; however, the food value of vegetable oils has been so high that it does not pay to make biodiesel. So the expansion goes forward, but with food in mind more than fuel. As a consequence, supply/demand balances for oil palm may change appreciably in five years, although it is not at all clear that near-term supplies of vegetable oil can be accelerated very much.

In addition to fuel and oils, wheat prices, which went off the charts in 2008, are closely tied to the corn economy. Corn and wheat are both used by the animal-feed industry, and, in some years, one quarter of the wheat crop is fed directly to animals. As the cost of using corn for feed rose in 2007, producers of livestock products looked to other grains. Since the feed value of wheat is slightly higher than that of corn, it is not surprising that their prices initially moved in tandem as livestock producers moved among markets to find the cheapest rations for their animals.

The wheat market has several distinguishing features. For example, soft wheat is used primarily for pastries (and feed), whereas hard wheat is preferred for bread. In the United States, the market for hard-red spring wheat was especially volatile. Prices doubled between February 2007 and February 2008, although new supplies from this year's harvest have begun to ease prices.

Wheat contributes less than 10 percent of the cost of a typical loaf of bread in the

United States. Nevertheless, its sharp price increase triggered broad increases in the prices of baked goods to cover the rising costs of raw materials, packaging, and distribution. For poor consumers in developing countries who get many of their calories from wheat products, the rising prices of bread, wheat tortillas, chapatis, and naan had immediate and profound nutritional consequences.

Two other disruptive forces were at work on the wheat crop overseas. The continuing drought in Australia, a major wheat-exporting country, was one of the few instances of supply failure in 2007. Exports from Australia fell by half, and since Australia traditionally supplies about 15 percent of global wheat exports, the drop added to rising bread prices around the world.

Second, one of the most ominous issues for the longer-run is the outbreak of a new wheat rust, Ug99. As the name suggests, this rust was discovered in Uganda in 1999, and its spores then spread by wind into North Africa and the Middle East. The rust has serious consequences for wheat yields. While actual losses to date have been rather small, future losses could be immense. Virtually none of the world's wheat varieties are resistant to the rust. Especially worrisome is its spread into South Asia where tens of millions of poor people depend directly on wheat for the bulk of their calories. The perception of a Ug99 threat has already had significant food-policy consequences in India (a point we return to later).

Finally, livestock products are part of this story about connections among commodities. In part, they help to push prices up. The growing pork sector in China, for example, exerted substantial upward pressures on world soybean markets. Most livestock producers in the United States and Europe, however, struggled to accommodate high-priced corn and other feeds. (One important exception took the form of distillers grains, a co-product of ethanol production. This residual is high in protein, and, if hauled in "wet" form directly from plants to dairies and feedlots, it provides cost advantages significant enough to transform feed rations, and potentially, to alter the geography of beef feedlots in the United States.)

In developed nations such as the United States, shrinking margins on livestock production are creating cutbacks. For example cattle have long gestation and maturation periods, and many cowherds are now being culled. Available meat on the market will increase in the short run, but a smaller supply of meat will eventually push prices up. Such price hikes will be felt mainly by middle- to upper-income households. Very poor consumers in low-income countries rarely consume meat of any sort, and for them the cutbacks may be an encouraging sign: their best hope is more grain available on world markets, rather than used as livestock feed or fuel in rich countries.

Much more could (and should) be said about individual commodities and about how recent macroeconomic trends have influenced the structures of markets. The expanded role of large hedge funds in commodity markets has increased price volatility for agricultural goods such as corn and wheat. For example, the number of corn contracts traded on the Chicago exchange has grown from 1 million in January 2002 to nearly 6 million in January 2008, leading some observers to conclude that there has been excessive financial speculation in these markets. The dollar has also depreciated rapidly during the past several years, virtually mirroring the rise in the price of oil. The dollar/euro price ratio is now only about 55 percent of what it was in 2000. If all commodity prices were quoted in euros, the price rises we have witnessed over the last two years would have been less steep. This obvious but important point underscores the central role that exchange rates play in both the world-food and oil economies.

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A farmer in Midsayap, North Cotabato, Philippines plants rice in muddy ground using a method called *sabog* or "spreading."

The story thus far has focused on commodities and their market connections. But food is much more than an economic commodity. It is also a political commodity and the foundation for human survival. Governments that cannot provide their constituents food at affordable prices are often overthrown. And for those that remain in power during times of high prices, particularly in poor countries, the challenge of feeding a growing hungry population looms. Food riots, politics, and new policies have all been on the forefront of the current crisis. As of April 2008, eighteen countries had reported food riots, from Bangladesh to Egypt, Haiti to Mexico, Uzbekistan to Senegal. About the same number of countries, including India, Argentina, and Vietnam, erected trade barriers on food to protect their domestic constituents.

Governments have reacted to the crisis in different ways, and these policy responses can have far-reaching effects in the world food economy. India, in particular, played a pivotal role in shaping the current crisis when its national food authority placed restrictions on staple cereal exports in October 2007. Higher prices in the international wheat market, coupled with the escalating threat of Ug99 and poor weather conditions within India's main cereal producing regions, triggered the new policy. Faced with less domestic wheat for public distribution and costly wheat imports, the government moved to guarantee supplies of its other main staple crop, rice, for its constituency. Bans were placed on exports of non-basmati varieties of rice, wheat, and wheat flour, and wheat imports were restricted for disease control. The move was geared in part to electoral politics—the upcoming 2009 elections—yet it had echoes, linking rice to the seemingly disconnected biofuels sector in the global commodity market.

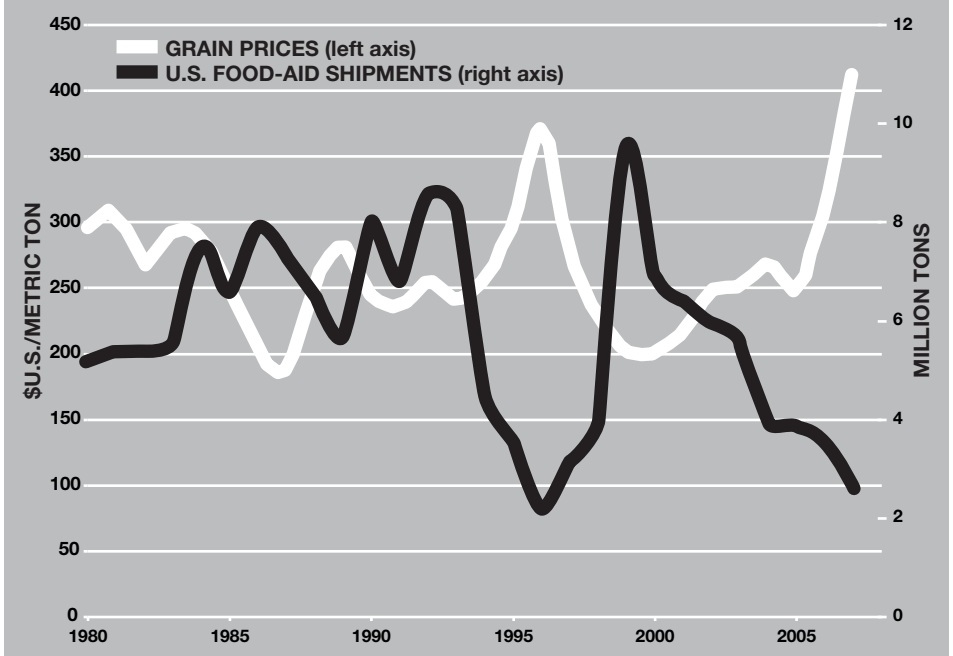
Food Insecurity by Region
(2001-2003)

REGION	MILLIONS OF UNDERNOURISHED	PROPORTION OF UNDERNOURISHED IN TOTAL POPULATION
East Asia	159.5	17%
Southeast Asia	65.3	12%
South Asia	298.5	22%
Latin America and Caribbean	52.4	10%
South America	33.3	9%
Near East	31.6	12%
North Africa	6.0	4%
Sub-Saharan Africa	206.2	32%
Eastern Europe	3.8	3%
Developing World	820.2	17%

Source: FAO State of Food Insecurity in the World, 2006

ILLUSTRATION BY BRAD LARRABEE

U.S. Food-Aid Shipments And Grain Prices (1980-2007)



Sources: Food Aid—1980-1996 from FAO; 1997-2006 from globalpolicy.org; 2007 from USDA. Grains prices—average annual wheat + maize price, International Monetary Fund.

ILLUSTRATION BY BRAD LARRABEE

Rice has historically carried great political weight in Asia. Unlike wheat and corn, which are much more freely traded in international markets, rice is consumed largely in countries where it is produced, and is exchanged to a great extent through government-to-government contracts. Although private sector investment and trade have expanded in recent decades, rice trade accounts for only 6 to 7 percent of total production, and Asian governments continue to keep a close eye on prices and availability for the sake of political stability.

Given India's role as the world's second largest rice exporter—in recent years supplying about five million metric tons or one-sixth of the world market—its export ban sent a shock to the system. The international rice price immediately jumped from about $300 to $400 per ton for standard grade rice and continued to soar to unprecedented levels as other countries reacted to the change. Shortly after India placed restrictions on rice exports, Vietnam, China, Cambodia, Indonesia, and Egypt followed suit. Meanwhile the Philippines—the world's largest importer of rice—began to place open tenders in the world market (bids for imports at any price) in April 2008 in a desperate act to secure adequate stocks of rice for its citizens. At this point, the price of rice rose to $850 per ton, and soon surpassed $1,000 per ton in May with additional tenders. But still the Philippines struggled to secure sufficient rice at even this high price.

Other countries fared even worse. Bangladesh suffered a major tropical storm in November 2007 that killed 3,400 people, left millions homeless, and demolished large tracts of agricultural land. The country lacked the financial reserves needed to import rice, even though India made an exception to sell limited quantities of non-basmati rice at $650 per ton. Similarly, Sub-Saharan African countries, which import on average 40 percent of their rice consumption (in southern African countries the number is as high as 80 percent), had no access to their usual supplies of Indian rice, and could neither find nor afford other sources of rice in the market. Reduced cereal imports triggered price increases in regionally grown crops such as millet and sorghum. Although farmers who produce a surplus of those crops have benefited, the poorest households that consume more than they produce have had to go with less, and have no doubt suffered increased malnutrition.

We are only beginning to understand the toll of price increases on the world's least developed and low-income food-deficit countries, many of which are in Sub-Saharan Africa. The Food and Agriculture Organization estimates that the 2008 food-import bill for these countries will rise up to 40 percent above 2007 costs, after rising 30 and 37 percent, respectively, the previous two years. The cost of annual food imports for these regions is now four times what it was at the beginning of the decade, even though import volumes have declined. The World Bank predicts that with these rising costs, declining imports, and increasing domestic prices of agricultural commodities, millions of people will fall quickly into chronic hunger.

Cameroon has experienced some of the worst strife as a result of high consumer prices. Roughly 1,600 protesters were arrested and 200 were sentenced in the first few weeks after riots broke out in February 2008. In an attempt to extend his quarter-century run in office, President Paul Biya's government not only clamped down on riots but also cut import duties and pledged to increase agricultural investments and public-sector wages.

In Argentina, a different form of food riot broke out against the newly elected President Cristina Fernandez de Kirchner when she raised export taxes on soybeans and implemented new taxes on wheat and other farm exports in order to hold domestic food prices down. Four months of nationwide protests by farm groups eventually persuaded the government to revoke these tax increases in mid-July, but political tension remains.

Governments thus walk a thin line between consumer- and producer-oriented incentives. Export restrictions in times of high world prices may help consumers, but

they prevent agricultural producers from realizing economic gains. Interventions of this sort may help in the short-term, but they are extremely hard to retract. For example, many Asian countries implemented trade restrictions on rice in the mid-1970s in response to high prices, short supplies, and political unrest, and these policies remained in effect for over two decades. It is clear that policies designed to stabilize domestic prices often destabilize international ones. And advocating international cooperation as a solution is naïve, as evidenced by the repeated (and recent) failure of World Trade Organization negotiations over the topic of coordinated agricultural policies.

The international community is addressing the mounting crisis in different ways. The United Nations World Food Program (WFP) received $2.6 billion in contributions for the first six months of 2008—almost as much as it received for the full year in 2007, but still below the amount needed to feed the growing number of starving people worldwide. Food aid deliveries in 2007 fell to their lowest levels since 1961, and the outlook for 2008 remains sobering.

The United States has earmarked about $2 billion for food aid through its Public Law 480 program, more than any other country. However, only about 40 percent of this amount is spent on food; the rest goes to transportation and administration to meet Congressional mandates that U.S.-produced commodities committed as aid must be shipped to their destinations on U.S.-flagged vessels. With energy prices soaring, the cost of shipping food aid over long distances has increased by more than 50 percent during the past year, and the actual amount of food aid has decreased. An increasingly embarrassing cycle has evolved whereby U.S. food aid is reduced when costs are high and food is most needed by the poor (see *U.S. Food Aid Shipments and Grain Prices, 1980-2007*).

Canada and the European Union, meanwhile, have followed the WFP strategy by providing food aid in the form of cash to relief agencies in needy countries. The agencies then purchase supplies regionally, a practice that reduces transportation costs and boosts local agricultural markets. A proposal to endorse this strategy in the United States fell flat in the Congress and was countered in the Senate by a bill that would spend $60 million over four years to study the idea.

Food assistance, however, is a band-aid, not a cure, especially because it may provide major disincentives for agricultural development in poor regions. Ironically, the United States, the largest donor of food aid, is one of the smallest donors (relative to GDP) of international development aid. Agricultural development has been largely eliminated from the agenda of the U.S. Agency for International Development in recent decades and the agency has lost most of its agricultural expertise. (When polled, Americans believe that up to one-quarter of the U.S. federal budget is spent on foreign aid, when in fact the share is less than 1 percent. If voters had the numbers in better perspective, perhaps they would push for an increase in assistance.)

Pigs raised in a small northern Vietnam village wait in their tightly bundled baskets to be transported for slaughter.

Over the longer run, only sustained growth in agricultural productivity can reduce the vulnerability of all countries to the chaos created by food crises. This conclusion is especially true for poor countries where over half of the workforce derive their principal income from agriculture, and the farm sector accounts for a sizeable share of GDP. But even rich countries such as the United States require continued investments in agricultural productivity—a point made clear by the fact that a large share of the corn crop now goes to fuel American gas tanks. Unfortunately, growth in public-sector investments in agricultural productivity research has slowed in many countries, rich and poor, although China, India, and Brazil have been clear exceptions. Private-sector agricultural investments have been more robust but have been focused mainly in rich countries and have resulted in the proliferation of biotechnology patents that have kept innovation largely out of public hands. The gap between the "haves" and "have-nots" of agricultural research is thus widening.

This pattern of agricultural investments is a key culprit in the current crisis, and it will continue to create serious problems for consumers worldwide if crop-based biofuel use expands further. Globally, agricultural productivity growth (2 percent per year from 1980-2004) is barely outpacing population growth (1.6 percent per annum). And even this minimal progress has not been evenly spread. Asia, and in particular China, has dominated the positive trend, while Sub-Saharan Africa has faltered with its grain yield at one-quarter that of East Asia's 1.6 tons per acre. (The industrialized world produced 2.4 tons per acre in 2004). Fortunately, bilateral donors are now taking an increasing interest in Sub-Saharan Africa, as are several important private foundations (a point discussed more thoroughly in the May / June 2008 issue of *Boston Review*).

The World Bank is in a position to reinvigorate agricultural development, both financially and symbolically. What is it currently doing to help? Fortunately, Robert Zoellick is providing international leadership on global agriculture that has long been overdue at the Bank. Allocations for agricultural development are now up; for example, the Bank has pledged to double agricultural lending in Africa from $400 million to $800 million in 2009. Yet the steady decline in the Bank's investments in agricultural research and development, cuts in its technical staff on agricultural development, and reductions in overall allocations to agriculture (from about 25 percent of total Bank lending in the mid-1980s to 10 percent in 2000) have done little to bolster infrastructure and agricultural capacity in the countries worst hit by the crisis. The non-trivial issues of corruption and poor governance in several African countries are partially to blame for this decline: Bank leaders have argued for funding cuts on the grounds that money given directly to governments for agricultural development never reaches targeted projects. But the Bank's leadership (prior to Paul Wolfowitz and now Zoellick) also lacked vision regarding the importance of agricultural development. The World Bank does not stand alone in this neglect; for example, the Asian Development Bank recently decided to omit agriculture from its lending portfolio. It is time for the international community of aid institutions and national governments to change direction on this issue.

It is one thing to commit to the new forms of food aid and additional investments in crop productivity needed to work through the current food crisis. It is quite another to plan for what will be needed to keep the world out of a perpetual food crisis in the face of global climate change. With increasing temperatures, rising sea levels, changing precipitation patterns, new pest and pathogen pressures, and reduced soil moisture in many regions, the impact on the agricultural

sector is likely to be especially severe. How can the international community grapple with the present challenges in the world food economy and still keep agricultural productivity ahead of a changing climate?

Predicting climate conditions decades in advance involves many uncertainties. Nonetheless, some twenty global climate models (also known as general circulation models) considered by the Intergovernmental Panel on Climate Change broadly agree on three points. First, all regions will become warmer. The marginal change in temperature will be greater at higher latitudes, although tropical regions are likely to be more sensitive to projected temperature changes because they have experienced less variation in the past. Second, soil moisture is expected to decline with higher temperatures and increased rates of evapotranspiration in many subtropical areas. These factors will lead to sustained drought conditions in some areas and flooding in others where rainfall intensity increases but soil moisture decreases. And third, sea levels will rise globally with thermal expansion of the oceans and glacial melt, with especially devastating consequences for small island states and for low-lying and highly populated regions.

Large areas of Bangladesh already flood on an annual basis and are likely to be submerged completely in the future. Moreover, the rapid melting of the Himalayan glaciers, which regulate the perennial flow in large rivers such as the Indus, Ganges, Brahmaputra, and Mekong, is expected to cause these river systems to experience shorter and more intense seasonal flow and more flooding, thus affecting large tracts of agricultural land.

Increased temperature and drought will pose large risks to food insecure populations, particularly in Sub-Saharan Africa and South Asia. Research at the University of Washington and Stanford University predicts that average growing season temperatures throughout the tropics and sub-tropics will rise above the bounds of historical extremes by the end of the century. Yield losses are expected be as high as 30–50 percent for corn in southern Africa if major adaptation measures are not pursued. Africa as a whole is particularly vulnerable to climate change since over half of the economic activity in most of the continent's poorest countries is derived from agriculture, and over 90 percent of the farming is on rain-fed lands.

Given the inevitable changes in climate over the coming decades, what forms of adaptation are needed, and how can the international community help?

One strategy is based on developing new crop varieties resistant to climate-induced stresses (heat, drought, new pests and pathogens). Introducing these climate-tolerant traits in crops will require continued collection, evaluation, deployment, and conservation of diverse crop genetic material, because the diversity of genetic resources is the building block for crop breeding. In the absence of such efforts, even temperate agricultural systems will suffer yield losses with large increases in seasonal temperature.

Additional adaptation strategies include investments in irrigation and transportation infrastructure and the design of climate information and insurance networks for farmers. The creation of non-farm employment will also help reduce climate change impacts in cases like the Sahel (the northern section of Africa below the Sahara desert and above the tropical zone) where agriculture may simply be unviable in the future.

All of these strategies involve large-scale investments in "public goods" that the private sector cannot be expected to fill. The U.S. government, for one, needs to recognize the global consequences of climate change and contribute to such public investments. Other governing bodies (e.g., those of Canada, the European Union, and East Asian countries) and international development organizations also need to play a greater role. Promoting pro-poor investments in agricultural productivity research and implementation—not allowing such investments to fall off the agenda—is the key to food security in the face of climate change. The future will look very much like a continuation of the current crisis—or indeed much worse—without such investments.

The complexity of the food crisis across commodities, space, and time makes it difficult to give a precise statement of causes. That said, the direct and indirect effects of increased ethanol production in response to rising oil prices seem to have pushed an already tight food system (with weak investment in innovation) over the edge. The U.S. Department of Agriculture's assessment that biofuels were 3 percent of the problem completely lacks credibility, and the International Food Policy Research Center's estimate of 30 percent may also be too low. What happens to future corn and vegetable oil prices, and therefore to the entire structure of food prices, is dependent primarily on the price of oil and on whether the new biofuel mandates for ethanol in the United States and biodiesel in Europe are imposed or rescinded.

The price of oil, in particular, is a fundamental factor in the overall equation. In a world of $50-per-barrel oil, growth in biofuels would have been more limited, with a much smaller spillover onto food prices. But the links that have emerged between agricultural and energy sectors will shape future investments and the well-being of farmers and consumers worldwide.

Misguided domestic policies serving particular groups of constituents in a wide range of countries are also driving the crisis. Export bans on food in response to populist pressures are likely to yield small and short-lived gains, while producing large and long-term damage to low-income consumers in other countries. The food system is indeed global, yet the principal actors are national governments, not international agencies. The latter can help with solutions, but fundamental improvements require more enlightened national policies.

As Zoellick's passage at the beginning of this essay implies, much of the current crisis could have been avoided and can be fixed over time. Individuals, national governments, and international institutions took agriculture for granted for twenty years, and their neglect has now caught up with the world. Fortunately, high food prices and the resulting political upheaval have induced national governments and such international institutions as the World Bank to pledge greater investments in agricultural development. Unfortunately, these pledges only came as a response to widespread malnutrition among the world's poorest households.

In response to rising demand and higher prices, some new sources of supply are emerging, including soybean expansion in Brazil and oil palm expansion in Indonesia. However, the environmental impacts of such expansion, particularly when it involves clearing tropical rainforests, are potentially serious. Similarly, efforts to increase crop yields in existing agricultural areas are leading to greater fertilizer inputs and losses to the surrounding environment. The trade-offs between agricultural productivity and environmental sustainability, particularly in an era of climate change, appear to be more extreme than ever before.

The current food crisis has different origins than previous global food crises, and will require different solutions. It also differs from famines in isolated geographic areas for which food aid and other palliatives can provide quick fixes. The present situation is instead reflected in higher infant mortality and poverty rates over a much wider geography. Given the underlying pressures of growing population, increasing global incomes, and the search for oil substitutes, leaders in both the public and private sectors in developed and developing nations need to be serious about expanded agricultural investments and improved food policies. Otherwise, the current situation will only get worse, especially for the 40 percent of the world's population that is already living so close to the edge. ♦