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# Overcoming the World Food and Agriculture Crisis through Policy Change and Science

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## 1. Introduction

Today's acute world food situation is shaped by volatility of food prices, low growth in agricultural productivity, and severe constraints on access to investment capital for agriculture. The sharp rise in global food prices in 2007–08 severely undermined the nutrition security of the poor, provoked social and political instability, and increased competition for already limited natural resources. The crisis, however, also renewed the focus on food and agriculture in national and global agendas, after decades of policy neglect and underinvestment in agricultural science, rural infrastructure, and rural institutions. India has responded particularly strongly to the challenges in the world food system with policy actions that will be discussed here in a global context.

Many studies have shown that spending on agricultural research and development (R&D) is one of the most effective types of investment for promoting growth and reducing poverty. For example, for every 1 million rupees spent on agricultural R&D in India in the 1990s, 323 poor people were lifted above the poverty line (Fan, Gulati, and Thorat 2008). Yet global investment in R&D has been stagnating, and current levels are hardly sufficient to work at the frontiers of science. This past underinvestment is now evident in the slow response of agricultural production in much of the developing regions to surging food demand and in the failure to prevent food price volatility. To serve as long-term insurance against emerging risks, including climate change, R&D investment needs to be ahead of the curve. Now that the global financial crunch and economic slowdown are letting the air out of the food price bubble, concrete policy changes and investments must be made to overcome the food crisis and allow the world food system to face new challenges and respond to new opportunities.

As policymakers consider policy and investment options, the following patterns of consensus, and lack of consensus, are

evident: First, there seems wide agreement that *innovations in agricultural practices and science* have crucial roles to play in boosting agricultural growth, coping with and recovering from the current world food crisis, as well as preventing similar crises in the future. Second, there is also broad agreement that science alone cannot change the world food situation, but that *institutional innovation and change* must facilitate farmers' profitable use of science and technology by reducing the transaction costs of gaining access to innovations and the impediments to selling the increased production in better market conditions. Third, however, there is little agreement about the *best designs of these institutional arrangements in specific contexts*: for instance, scales in farming and food industries; contract and cooperation choices; roles of public and private sectors along the food value chains; market and trade arrangements; taxation, subsidies, and pricing; public sector actions in agriculture at central or local government levels; and civil society's roles. Fourth, it seems that—although there is underinvestment in food and agricultural science and technology—*innovation in institutional arrangements are lagging behind even more*, and hinder progress in the use of technology and in reducing hunger through public and market-based actions.

This paper focuses on these issues and how they may be addressed. An international perspective is taken here, with some focus on South Asia's rich experiences. The discussion of these issues is connected to a policy proposal to overcome the world food and agricultural crisis, composed of three sets of needed complementary actions:

- (1) promote pro-poor agricultural growth,
- (2) reduce market volatility, and
- (3) expand social protection and child nutrition action.

Each of these policy actions needs to be enhanced by science and by institutional innovations.

## 2. The Food Price Crisis and Its Impacts

Driven by rapid growth in food demand, the world price of almost every agricultural commodity sharply increased in 2007 and 2008. At their peaks, world rice prices increased fivefold and wheat and maize prices tripled compared with their levels at the beginning of 2003 (FAO 2009a). At the country level, these global food price changes have been transmitted to different degrees owing to factors such as transportation costs, domestic policies, and market structure. In many developing countries, including the countries in South Asia, food price increases led inflation dynamics because of the large share of food in the consumption basket (Figure 1). By putting upward pressure on overall inflation, they had adverse macro-economic effects and increased uncertainty and distorted economic planning.

Some countries, such as India, used subsidy, trade, and tariff policies to absorb much of the shock in global food prices. Indeed, wholesale rice and wheat prices in India increased by 30 percent from the beginning of 2003 to October 2008 (Ministry of Commerce and Industry of India 2009). Many least-developed countries, however, had fewer resources to respond in a similar manner and many were hard hit by measures such as export restrictions on agricultural commodities of major producers. Indeed, countries that imposed export restrictions may have reduced their own risk of food shortage in the short term, but they hurt import-dependent trading partners and made the international market smaller and more volatile. General price changes also affected local non-traded foods, suggesting that self-sufficiency is not a solution to the food price crisis.

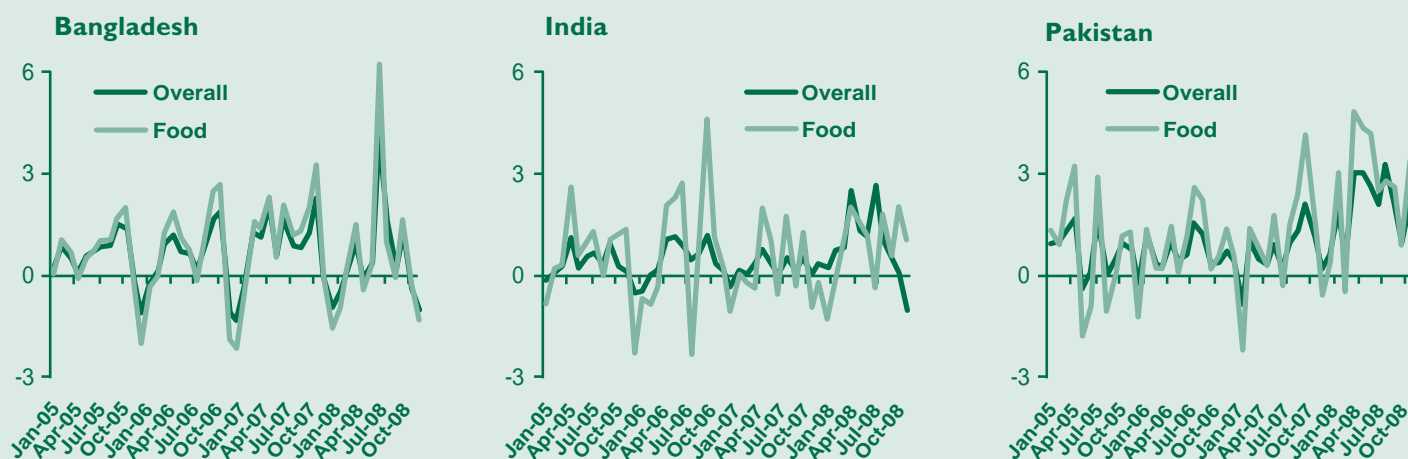
Slowing demand and higher production have now eased the food price spike. International cereal prices have fallen by about 40 to 60 percent from their peaks, but they remain high compared with a couple of years ago, and, in some regions, such as East Africa, have actually not declined much.

**Impacts on the poor and hungry.** Even before the food crisis hit, roughly 160 million people were living in ultra poverty, on less than 50 cents a day (Ahmed et al. 2007). The number of undernourished people in developing countries has been increasing and is largest in South Asia. The 2008 Global Hunger Index (GHI)<sup>1</sup> shows only a slight improvement in the overall world hunger situation since 1990 (von Grebmer et al. 2008). When Indian states are compared with the 88 countries in the GHI, their rankings range from 34th (Punjab) to 82nd (Madhya Pradesh) (Menon, Deolalikar, and Bhaskar 2008). Despite this large variability, all Indian states have at least a “serious” level of hunger. Child undernutrition in India is particularly grave. India is home to 40 percent of the world’s malnourished children and 35 percent of developing countries’ infants born with low birth weights (von Braun, Ruel, and Gulati 2008).

For the poor in many countries, the food price crisis has been a major threat to food security and livelihoods. Poor people spend 50 to 70 percent of their income on food, and they have little capacity to adapt to rapidly rising prices and are hit hardest by price volatility. Also, the wages of many of the most vulnerable did not adjust to compensate for their shrinking purchasing power. Poor households had to limit their food consumption, shift to even less-balanced diets, and spend less on other goods and services that are essential for their health and welfare, such as clean water, sanitation, education, and health care. According to preliminary estimates of the Food and

<sup>1</sup> The GHI is a combined measure of three equally weighted components: (1) the proportion of undernourished as a percentage of the population, (2) the prevalence of underweight in children under the age of five, and (3) the under-five mortality rate. The 2008 GHI is based on data up to 2006 – the last year with data available at the time of publication.

**Figure 1—Food and overall inflation, month-to-month change (%)**



Source: Based on data from ILO 2009 and Ministry of Commerce and Industry of India 2009.

Note: Inflation for Bangladesh and Pakistan is based on consumer prices, and inflation in India is based on wholesale prices.

Agriculture Organization of the United Nations (FAO), the number of undernourished people increased from 848 million to 963 million between 2002–05 and 2008, largely because of the food price crisis (FAO 2008a). Food price hikes have also worsened micronutrient deficiencies, with negative consequences for people’s nutrition and health, such as impaired cognitive development, lower resistance to disease, and increased risks during childbirth for both mothers and children. In Bangladesh, for example, a 50 percent increase in the price of food is estimated to raise the prevalence of iron deficiency among women and children by 25 percent (Bouis 2008). Indeed, food crises affect women more deeply and for longer because they more often lack the income and assets that could help them cope with the crisis than men (Quisumbing et al. 2008). With the cost of food and other essentials increasing, people have taken to the streets in protest. Social and political unrest has occurred in more than 60 countries since the beginning of 2007, with some countries experiencing multiple occurrences and a high degree of violence.

The global financial crisis and recession are now adding to the burden on the poor. Wages are lost as jobs are cut around the globe. Many small farmers who took advantage of rising agricultural prices to invest in agricultural technologies find themselves unable to pay off their debts. Compared with previous crises, the recent financial crisis has affected many more of the poor in all corners of the world, because a large share of the most vulnerable people is dependent on wages. Also, given that children’s undernutrition affects their physical and cognitive development and has implications for their earnings as adults, the crises will have long-lasting negative implications for people’s economic prospects long after prices come down and the credit crunch is resolved. If the recession is not overcome quickly and investments in agriculture are not accelerated, the consequences could be severe. IFPRI estimates that recession and reduced investment in agriculture would raise international grain prices by 30 percent and push 16 million more children into malnutrition in 2020 compared with continued high economic growth and maintained investments (von Braun 2008).

**Impacts on agriculture and natural resources.** Underinvestment in public goods—such as agricultural research, science and technology, rural infrastructure, and information and monitoring—has impaired agricultural productivity and production growth as demand for food has risen rapidly. Indeed, annual world cereal yield growth has declined from about 3 percent in the 1960s and 1970s to less than 1 percent since 2000 (World Bank 2007). Total factor productivity (derived from the ratio of total output growth to total input growth) in developing countries grew by 2.1 percent per year from 1992 to 2003 on average; in South Asia, the annual rate of growth was even lower—only 1 percent (Table 1). In India, public investment in agricultural research equals only about 0.5 percent of agricultural gross domestic product (GDP), which is lower than the 0.7 percent average for developing countries and the 2–3 percent average for developed countries (von Braun et al. 2009). In 2005–07, cereal yields in India grew on average by 2.5 percent a year (FAO 2009c).

High food prices in 2007–08 and favorable weather provided incentives for agricultural expansion, but most of the increase in output has occurred in developed countries. Many developing countries have been unable to generate the desired production response. If Brazil, China, and India are excluded, total cereal production in the rest of the developing countries actually fell by 1.6 percent in 2008 (FAO 2008b). In India, the grain harvest was particularly good—213 million tons in 2007–08 compared with 194 million tons in 2006. Now, however, as capital becomes more expensive and scarce, plans for investment in agriculture across the globe are at risk of being postponed or scaled back.

Agriculture is also facing a serious crunch in natural resources, including land, water, and ecosystems. Population growth, industrial expansion, urbanization, and agriculture itself have led to resource degradation and overexploitation. The food price crisis has augmented competition for land and water for agriculture. Increased scarcity of land led to rising farmland prices and accelerated deforestation. In 2007, farmland prices jumped by 16 percent in Brazil, by 31 percent in Poland, and by 15 percent in the midwestern United States, according to news reports. Constraints in capital can also lead to overuse of both land and water.

**Table 1—Total factor productivity growth in developing-country regions, 1992–2003**

Region	Average annual growth (%)				
	1992–94	1995–97	1998–2000	2001–03	1992–2003
<b>East Asia</b>	5.0	4.5	-1.1	2.5	<b>2.7</b>
<b>South Asia</b>	1.7	-0.2	1.2	1.4	<b>1.0</b>
<b>East Africa</b>	-1.7	2.0	0.2	1.3	<b>0.4</b>
<b>West Africa</b>	1.8	2.5	2.4	-0.1	<b>1.6</b>
<b>Southern Africa</b>	0.4	3.3	3.6	-0.6	<b>1.3</b>
<b>Latin America</b>	1.8	2.0	2.9	4.3	<b>2.7</b>
<b>North Africa and West Asia</b>	-0.1	1.9	1.5	2.8	<b>1.4</b>
<b>All regions</b>	2.8	2.7	0.6	2.5	<b>2.1</b>

Source: von Braun, Fan, et al. 2008.

Pressures on natural resources, combined with increasing distrust in the functioning of regional and global markets in the wake of the price crisis, have led to increased new forms of government-to-government foreign direct investment in agriculture. A number of countries, many with severe natural resource constraints but rich in capital, have turned to overseas investment in agriculture to secure domestic supply. According to news reports, Qatar, Jordan, Kuwait, and the United Arab Emirates have invested in Sudan; India and Kuwait have invested in Burma; China has invested in Mozambique, the Philippines, and Zimbabwe. These agreements help reduce underinvestment in agriculture, but recipient countries need to negotiate contracts wisely and establish an enforceable code of conduct, including rules about sustainable management of natural resources, engagement of local producers, and respect for customary property rights.

### 3. India's Response to the Food Crisis

After reaching impressive rates of 9–10 percent a year in 2006–07, economic growth in India slowed to 7 percent in 2008 owing to the recent world food and financial crises and is projected to decline to 5 percent in 2009 (IMF 2009). As further recession challenges arise, agriculture has an increasingly important role to play in India's economic development. Agricultural growth has been low on average, with annual growth in 2004–06 at below 3 percent (World Bank 2007), and this trend needs to be reversed.

India's quick and comprehensive response to high world food prices and its good grain harvest in 2007–08 made the immediate impact of the crisis less drastic than in other countries. Indian policymakers saw that at a time of high global food prices, cereal productivity growth in India had been slowing down, a large quantity of food was needed to feed a large and growing population of 1.1 billion people, and the country's food import bill had been swelling. In response, India imposed export restrictions on major grains; expanded subsidies on crude oil, fertilizers, and food; and sustained safety net programs such as the Public Distribution System (PDS) and the National Rural Employment Guarantee Scheme (NREGS) (Gulati and Dutta 2008). Some of these responses, such as export controls on rice and wheat and withdrawal of these cereals from the futures markets, actually bumped up global prices, especially for rice. India must, however, reverse this protectionist trend in order to avoid threatening the domestic benefits of its liberalization of agrifood markets in the 1990s and to prevent harm to importing partners. Unlike other countries, India accumulated large grain buffer stocks both before and during the crisis. With grain stocks of more than 35 million tons in 2008, India has already surpassed its estimated stock norm by 10 million tons and is projected to increase its stocks further to 39 million tons this year (FAO 2009b). An institutional arrangement is needed to govern the appropriate level of stocks and their timely release to reduce food market volatility (see Section 8).

As a step in the right direction, the government of India

increased its investment in agriculture and social protection by 24 percent in its 2008 budget (India Ministry of Finance 2008). To enhance food security, it established a National Food Security Mission in August 2007 with the goal of sustainably increasing agricultural productivity and production. Focusing on the eastern part of the country, the scheme aims to raise production of rice by 10 million tons, wheat by 8 million tons, and pulses by 2 million tons by 2011–12. Given that productivity on irrigated land is almost double that on rainfed land, the government plans to substantially improve irrigation systems. In its 2008 budget, the government raised the allocation to irrigation by 80 percent. This irrigation investment needs to be accompanied by institutional and price reforms.

Further, India has maintained and expanded its safety nets in the context of the food price crisis. Food and fertilizer prices under the PDS have remained constant in nominal terms and declined in real terms. Issue prices are now almost half of the open market prices, and states such as Andhra Pradesh distribute rice at prices as low as US\$0.04 a kilogram. In addition, the NREGS introduced in 2006–07 was scaled up substantially. In February 2009, the scheme's allocation was increased from US\$ 3 billion to \$6 billion. Although these programs have cushioned some of the negative impact on the poor, they come at a high cost. The PDS food and fertilizer subsidy, for example, increased to almost \$20 billion, raising the budget deficit to somewhat unsustainable levels.<sup>2</sup> The targeting mechanisms, coverage, and cost-effectiveness of many safety net programs are not always optimal and need to be revisited (von Braun et al. 2009).

### 4. The Role of Science and Institutional Innovation in Responding to the Food Crisis

Technological breakthroughs, and their adoption on a large scale as in the Green Revolution in Asia in the 1960s and 1970s, have been critical in preventing Malthusian outcomes. Yet agricultural growth in many developing countries continues to be hampered by lack of appropriate agricultural technologies, immense institutional constraints, and serious problems with the organization and management of agricultural systems.

Agricultural technology, with only a few exceptions, is not an easy candidate for leapfrogging, and it requires substantial joint investments in areas such as rural education, infrastructure, and extension services. Thus, innovations in technology need to go hand in hand with innovations in policies and institutions that can boost growth, cope with and recover from the world food crisis, and prevent similar crises in the future. Innovations are critical for improving the livelihoods of smallholder farmers and reducing poverty and hunger in general (Asenso-Okyere, Davis, and Aredo 2008). These include innovations in

- organizations for agricultural research, extension, education, input supplies, marketing, and collective action;
- technologies along the whole food value chain;
- institutions, including laws, regulations, traditions, customs, beliefs, and norms; and
- public policies for promoting agriculture.

<sup>2</sup> Discussion based on information from Ashok Gulati, February 2009.

All of these innovations should be designed and implemented in synchrony, since each type has constraints and each complements the others.

But how would appropriate and timely innovations come about? It has been shown that changes in technology and the relative prices of factor endowments can induce institutional change (see, for example, Hayami and Ruttan 1971). Today, the conditions exist for inducing innovation in public research institutions. Prices of food, land, and water, have been on the rise. Political and macroeconomic stability are increasingly at risk. And there is a broad understanding that current levels of productivity growth are too low. Priorities for agricultural research have started to shift, and there are calls for increasing investment in research and development. To carry this trend forward, the theory of induced institutional innovation is a useful paradigm to consider, but a wide range of approaches should be taken into account and the debate should be freed from rigidities.

New institutional arrangements should be designed to help reduce the cost of scientific research, add value to research by facilitating innovation, and enhance the impact of research on smallholders and other marginalized groups in developing-country agriculture (Spielman, Hartwich, and von Grebmer 2007). Examples of successful institutional innovations include public-private partnerships, farm cooperatives, and social networks for the adoption of innovation. Yet different innovations are appropriate in different contexts. There is scope to learn from the multitude of success stories and use them as models for the future.

Innovations should not only strive to promote agricultural productivity, but also assist smallholders in reaching new, often higher-value, markets. Public-private partnerships and organized producer groups have been successful tools for helping smallholders comply with higher food safety requirements and reduce transaction costs (see, for example, Narrod et al. 2007). It is also important that innovations include women and disadvantaged groups. A recent study in Maharashtra, India, shows not only that social networks are crucial mediators in the process of technology adoption, but also that increased involvement of women enhances collective action (Padmaja and Bantilan 2007).

Initially, it was thought that institutions would improve as a consequence of individuals self interest and therefore take care of transaction costs and information asymmetries. Reality has shown that the presence of coordination failure, innovation failure, and authority failure are behind the failure of institutions to emerge efficiently. The high risks of production and cycles of over-supply and price depression create financial risks throughout the distribution chain that inhibit investment and access to capital. Monopolistic practices, corruption, and excessive regulations also add to the burden of the rural marketplace. The high costs, risks, and “friction” in rural agricultural markets prevents markets from achieving sufficient scale for efficiency and similarly prevent the low-cost and reliable supply

of production inputs such as seed, fertilizer, and other goods to farmers. The very poor farmers also lack the political power, market knowledge, and business knowledge to address these market roadblocks. Thus poor rural farmers lack the capacity to improve and influence the markets upon which their lives depend. But some of these assets can be developed through effective organization, technical training, and means for assembly and communication.

Institutions play five potential roles in strengthening markets for commodities produced, bought, and sold by smallholders: reducing transaction costs; managing risk; building social capital; enabling collective action; and redressing missing markets. It is increasingly clear that the institutional infrastructure to facilitate market exchange is a critically important area to countries recently experiencing the shortfalls of market liberalization, specifically for smallholder agriculture. When market information and markets themselves are not accessible to the rural poor, farmers capture little of the value that they create, demand and supply are highly unstable, and distribution costs for rurally produced goods are very high. Simply put, often markets do not work very well for the poor.

Therefore the major innovations that should be included are

- i) organizations in agricultural research, extension, education, input supplies, marketing, and collective action;
- ii) technologies along the whole food value chain;
- iii) reduction of transaction costs through innovative institutional designs in the access to ICT technologies;
- iv) contract farming and collective action;
- v) institutions including laws, regulations, traditions, customs, beliefs, norms;
- vi) public policies for promoting risk coping among farmers; and
- vii) public policies for promoting agriculture.

All of these innovations should be designed and implemented in synchrony, since each type has constraints and they complement each other. Two examples shall illustrate the importance of innovations in institutional designs: reduction of transaction costs by reducing asymmetry of information through ICTs, and vertical and horizontal coordination as a mechanism to better link smallholder farmers to dynamic markets (contract farming and collective action through rural producer organizations).

**On using ICTs to reduce asymmetry of information and transactions costs.** The literature has largely focused on barriers to agricultural production, implicitly assuming that if the crop were produced, the farmer would receive the higher average price and hence higher average return. However, just as small farmers have lower access to capital and technical expertise, they may have imperfect access to markets for their produce.<sup>3</sup> For example,

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<sup>3</sup> In some parts of Africa, marketing constraints arise because the markets for food crops are imperfect or missing. For example, Jayne (1994) finds that the cost of acquiring food grains through the market is so high, that small foodgrain-producers in Zimbabwe cannot afford to diversify into oilseed production. Goetz (1993) argues that in the absence of a market for foodgrains, Senegalese farmers engage in intra-household specialization in cash and food crop production, and crops are exchanged within the household.

small farmers in many parts of South Asia tend to sell their produce to middlemen, instead of visiting the market directly. If this reduces the flexibility of sales decisions, it can lead to inefficiency. Studies of crop production are typically unable to capture these important nuances; for example, the Government of West Bengal's cost of cultivation study assumes that each crop is sold at the average price prevailing in the market eight weeks after the harvest. However, studies suggest that in West Bengal, small farmers of potatoes earn lower prices for their crops than large farmers do (Sarkar and Mitra (2002), Mitra and Sarkar (2003)). Their argument is that farmers lack information about daily prices of potatoes, and hence are unable to time their sales optimally. In contrast, large farmers are networked and well-informed, and have the resources to transport their potatoes to the markets independently. As a result, they can sell their potatoes when the prices are relatively high.

A central task therefore is to find innovative institutional designs to evaluate the information constraints faced by small farmers. It may be costly for a farmer to obtain daily price information on a regular basis<sup>4</sup>. He may lack the networks to access this information, or the wherewithal to verify it and distinguish correct information from rumors. But if providing broader access to information can increase returns and participation in high-value crops, this can have an important policy implication. The improvements in information and communication technologies (ICTs) in developing countries, and especially in Asia, gives a great opportunity for this to happen and could result in increased agricultural productivity, reduced transaction costs, opening of new markets, and provision of additional positive network externalities (Torero and von Braun 2006).

#### **On institutional innovations for contract farming.**

Research at IFPRI has demonstrated the importance of vertical coordination arrangements such as contract farming for the viability of small farms in high-value markets. The studies point out that the gains to farmers in terms of higher incomes from vertical coordination in high-value commodities are significant (Minot et al 2006; Roy and Thorat 2006; Gupta and Roy 2006; Lapar et al 2006; Birthal et al 2005). The significant gains to the farmers point to the inefficiencies that exist in the traditional marketing chains. Research has, moreover, demonstrated the important role of contract farming in reducing risk for the small farmers by sharing of risk between the contractor and small farmers (Ramaswami et al 2006). Other studies show the important role that the coordination arrangements play in enabling small farmers in meeting the stringent food safety standards in high-value markets (Narrod et al 2006 and Roy and Thorat 2006). Studies confirm the disadvantage of the small farmers with regard to transaction and marketing costs in relation to the larger farmers (Rich and Narrod 2006). Thus, the linkages with small farmers has to be innovative to the extent that they need to bring down the transaction and marketing costs of dealing with a large group of small farmers (Minot and Roy 2006; Gulati et

al 2006). In absence of laws and institutions supporting contracting in developing countries, enforcement of contracts and incidence of mistrust has at times been a problem (Singh 2002; Dev and Chandrasekhar 2004). Interestingly, while there is a tendency for contracts to go to larger farmers, research shows that access to small farmers might be advantageous to a firm, mainly because it increases the firm's capacity to respond to market conditions. These are gains to coordination that are not mediated by markets. While the technological barriers of small farmers into contract farming are real and important, evidence shows that incentives problems are partially responsible for the failure of contract farming among smallholders.

## **5. Global Policy Actions to Overcome the Crisis**

A comprehensive set of complementary policy actions is needed to overcome the world food and agriculture crisis: (1) promote sustainable pro-poor agricultural growth, (2) reduce market volatility, and (3) expand social protection and child nutrition action. In all of these areas, science and institutional innovations are needed to complement and enhance the effectiveness of policies.

**Promote sustainable pro-poor agricultural growth.** To enhance agricultural productivity, investments should be scaled up in the areas of R&D, rural infrastructure, rural institutions, and information monitoring and sharing. A recent study by IFPRI shows that if investments in public agricultural research were doubled, agricultural output would increase significantly and millions of people would emerge from poverty (von Braun, Fan, et al. 2008). If these investments were targeted at the poor regions of the world—Sub-Saharan Africa and South Asia—overall agricultural output growth would increase by 1.1 percentage points a year and lift about 282 million people out of poverty by 2020. Not all investments, however, are equally worthwhile. International agricultural research projects with substantial payoffs for a large number of beneficiaries should be given investment priority. The “best bets” identified by the centers of the Consultative Group on International Agricultural Research (CGIAR) include innovative programs to revitalize yield growth in intensive cereal systems in Asia, increase small-scale fish production, address threatening pests like virulent wheat rust, tackle cattle diseases such as East Coast Fever, breed maize that can be grown in drought-prone areas, and scale up biofortified food crops that are rich in micronutrients such as vitamin A, zinc, and iron. Institutional innovations such as public-private partnerships, social networks, and participatory research can greatly help in the transfer and adoption of innovation by smallholders and in adapting innovations to farmer's needs and capacities.

**Reduce market volatility.** Lack of information can lead to market inefficiencies and reduce the extent of mutually beneficial exchanges (von Braun and Torero 2006). The spread of new information and communication technologies has significantly improved market information and welfare. The wide adoption of cell phones in Kerala, India, has given fishers access to

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<sup>4</sup>In the absence of independent sources of information, entrepreneurs might rely on their trading partners for information about the state of the market. For example, Umali (1990) found that ricemillers in the Philippines are an important source of price information for traders of paddy.

different market prices, as well as opportunities to complete market transactions, without being physically present. As a result, a uniform price was offered across markets, fishers' profits increased by 8 percent, and waste of daily catch was completely eliminated (Jensen 2007). Market reforms should be accompanied by complementary investments in market infrastructure. Tanzania, for example, reformed its state-run minimum-price marketing setup in the late 1980s and early 1990s to allow private traders to buy and transport grain, but because no improvements were made in infrastructure, the reform led to increased price volatility (Kilima et al. 2008).

Reforms and innovations are also needed in global commodity markets. India should further promote futures trading to minimize market risks and promote further investment in commodities. At the global level, two collective actions are needed to protect the poor, improve market efficiency, and strengthen long-term investment incentives in agriculture. First, a small physical reserve must be established to facilitate smooth emergency response. The physical reserve could be managed, for example, by the World Food Programme. Second, an innovative "virtual reserve" should be created to help avoid the next price spike. The virtual reserve could be implemented by the Group of Eight Plus Five and some other large grain-exporting countries. The organizational design could include a permanent high-level technical commission that would intervene in futures markets and a global intelligence unit that would signal when prices head toward a bubble. Usually, intervention would not be necessary, and the whole operation would remain promissory or virtual.

**Expand social protection and child nutrition action.** To protect the basic nutrition of the most vulnerable and ensure food security for more of the world's population, sustainable pro-poor agricultural growth and reduced market volatility should be accompanied by social protection and child nutrition actions. Protective actions are needed to mitigate short-term risks, and preventive actions are needed to avoid long-term negative consequences. Protective interventions include conditional cash transfers, pension systems, and employment programs. Preventive health and nutrition interventions such as school feeding and programs for improved early childhood nutrition should be targeted to vulnerable groups and strengthened and expanded to ensure universal coverage. To aid the poor, these programs should go beyond social assistance and provide social development opportunities by building up physical and social assets (von Braun et al. 2009). Tying cash or food transfers to school attendance has been a successful institutional innovation in social programs. Mexico's PROGRESA, a large-scale conditional cash transfer program for poor rural households, increased the years of educational attainment by 10 percent and raised median caloric acquisition by 11 percent, among other benefits (Skoufias 2005). Bangladesh's food-for-education program increased school participation rates by 20–30 percent and girl's lifetime earnings by 33–35 percent (Science Council 2006). India's programs, such as the ICDS, can utilize and adapt these experiences. In addition to social safety nets, new instruments should be designed to help farmers manage risks in times of crisis, with the involvement of the

private sector. For example, innovative crop insurance programs for smallholders could be partially financed by governments or donors and contracted out to private firms for implementation.

## 6. Conclusion

The design of specific national strategies must be country driven and country owned, with country-specific priorities and sequencing. Rigorous analysis of the impacts of knowledge and innovation is essential and should have three components: (1) well-structured documentation and monitoring of programs and their changes, (2) analyses of innovation initiatives' impacts in comparison with counterfactuals, rather than just descriptive accounts, and (3) experimental designs with specific institutional and technical innovations that allow for comparisons in the real world context to enhance learning. Given that prioritization, sequencing, transparency, and accountability are also crucial for successful implementation, policy and governance practices in many developing countries must be strengthened. At the same time, new partners should be involved on a greater scale in policy design and implementation. The private sector and nongovernmental organizations are becoming increasingly interested in and involved with developing countries and the development community. Action should be taken now on strategic policies and investments for agriculture and the food-insecure poor.

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