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Never an Empty Bowl:
Sustaining Food Security in Asia

Asia Society and International Rice Research Institute
Task Force Report

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Task Force on Food Security and Sustainability in Asia

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Foreword

For the first time in history, the number of people suffering from chronic hunger has reached one billion globally, with Asia accounting for approximately two-thirds of the world's hungry. The future looks even more daunting. Population growth, increasing demand from changing diets, dwindling land and water resources for agriculture, higher energy costs, and the huge uncertainties regarding the effects of climate change present scientists and policy makers with additional challenges.

In an effort to address these urgent issues and mobilize resources at the public and private level, the Asia Society and the International Rice Research Institute (IRRI) established a high-level Task Force on Food Security and Sustainability in Asia to assess the current state of food insecurity in the region, with an emphasis on rice production. This unique Asia Society/IRRI linkage brings together a pragmatic approach to public policy and the best science, with substantial input from key players in the field, to advance a comprehensive plan of action. This report presents a range of steps that governments, businesses, NGOs, and regional and international organizations can take to tackle the challenges in this area. It is clear that innovative partnerships among these entities will be essential to making progress. Public-private partnerships are already emerging in the areas of crop technologies and provisioning school feeding programs, for example, and we also note the need for more partnerships involving different levels of government, civil society organizations, and donor organizations. Civil society organizations in Asia are particularly interested in being active members in these emerging partnerships.

Traditionally, improvements in rice technology and in farm productivity have been the main avenue for addressing problems related to food security. Indeed, rice availability and food security have long been synonymous in Asia, especially in the political arena. Despite rapid economic growth, sharply reduced poverty levels, and extensive diversification of the average diet in Asia, the dominance of rice remains a reality in the region's food security. As such, the Task Force's report focuses on the role of rice in sustaining Asia's food security, and aims to provide a thorough assessment of the potential for continuing gains in rice productivity. At the same time, the Task Force realizes that food security extends well beyond the role of rice production and consumption, and an assessment of the non-rice dimensions of food security in Asia is also provided in this report. The way forward in Asia will be through a "rice lens," with all of the broader dimensions incorporated through that lens.

On behalf of the Asia Society, I wish to thank Task Force chairs Dan Glickman and M.S. Swaminathan for their leadership, and all Task Force members who brought their depth of experience to this project. The Society is indebted to our partners in this effort, the International Rice Research Institute, especially Robert Zeigler, Achim Dobermann, Duncan Macintosh, and the many researchers and scientists at IRRI who contributed substantial expertise and insight. Special thanks are due to our principal adviser and lead author, C. Peter Timmer, who brought his deep knowledge and innovative thinking to the

drafting of this report. I am grateful to the experts who participated in the Society's 2010 Williamsburg Conference, which was led by Jamie Metzl and Mike Kulma, for providing constructive feedback on the Task Force's initial recommendations. I also wish to thank Richard Edelman, Sarah D'Souza, Renata Jendrolovits, and Bob Knott at Edelman for providing indispensable advice along the way, and Asia Society Trustee Leon Black, the Ford Foundation, and the Rockefeller Foundation, whose support made this project possible.

Finally, I would like to thank Suzanne DiMaggio, Director of Policy Studies at the Asia Society, who led this project with tremendous insight, skill, and energy, and project manager Robert W. Hsu for his invaluable support in coordinating all aspects of the project, from background research to the report's publication.

Vishakha N. Desai
President, Asia Society

Executive Summary

Asia's ability to feed itself is of fundamental importance not only to the people living in the region, but also to the world. One of the bright spots over the past half-century has been Asia's capacity to lift many of its citizens out of poverty and ensure that they have plentiful, inexpensive supplies of food, including rice, the region's main staple. But Asia still accounts for about 65% of the world's hungry population, and the historical gains from the Green Revolution are increasingly at risk. Declining trends in agricultural research and rural investment may lead to long-term food supply shortages and increased vulnerability to the famines that used to plague the region.

Food insecurity in Asia is full of contradictions, acute in some places and banished in others. The region is home to the world's two biggest rice exporters—Thailand and Vietnam—but also the biggest importer—the Philippines (and, historically, Indonesia)—and the two giants of global food production and consumption—China and India. A number of interrelated factors contribute to food insecurity in Asia. Foremost among them is poverty. The sheer magnitude of poverty and hunger in Asia is often masked by the dynamic macro economies in the region. Beneath that dynamism, however, lie stagnant, even declining levels of welfare for many households. Nearly two-thirds of the world's 1.4 billion poor live in Asia, and they spend on average about half of their income on food. For those making less than US$1.25 a day, access to adequate food from the market is often too costly.[1] Asia's rural poor, most of whom do not have enough land to be surplus producers of rice, are especially vulnerable.

Nearly 560 million people living on less than $1.25 (in purchasing power parity, or PPP) per day are in rice-producing areas, far more than for any other crop (*see Appendix 1*). Asia, where about 90% of rice is grown, has more than 200 million rice farms, most of which are smaller than 1 hectare. Rice is the staple food for most of the poor in Asia, where poverty remains staggering, particularly in South Asia. For the extreme poor who survive on less than $1.25 per day, rice, on average, accounts for nearly half of their food expenditures and one-fifth of total household expenditures. This group alone annually spends the equivalent of $62 billion (PPP) for rice.

The problems of hunger and malnutrition extend well beyond the availability of rice, although inadequate access to this basic source of food energy remains a problem for millions of households. Especially in South Asia, the nutritional status of mothers and children is not improving even as fast as the slow rate of poverty reduction. Sustainable improvements in food security in Asia must incorporate specific nutritional initiatives into the program designs, some of which might be mediated by rice with improved nutritional qualities, such as for iron or zinc. Although this report has a special focus on the role of rice in Asia's food security, it also attempts to incorporate the full range of food security

[1] Asian Development Bank (ADB), *Soaring Food Prices: Response to the Crisis* (Manila: Asian Development Bank, May 2008).

concerns—availability, access, and utilization—into the analysis and recommendations.

Another factor contributing to food insecurity is increasing demand from Asia's large and growing population. At current consumption levels per capita, rice production would need to grow by roughly 4 million metric tons (mmt) each year because of population growth.[2] Additional cereal demand comes from the shift to more protein-rich diets (which are much more nutritious than diets that derive the majority of their calories from rice, but which can be cereal-intensive because of utilization of cereal crops as livestock feed).[3] Rapid economic growth in China and India has diversified food demand and improved the quality of diets, while also creating opportunities for changes in rice-based systems to include higher-value crops and livestock. But one consequence is the reduced amount of land available for rice. The rice-related tensions that developing countries face are growing more complex as their economies grow: between poor rice farmers and poor consumers, between small-scale and large-scale rice-based farms, between rice and more lucrative cash crops, between edible crops and biofuels, between crops and other land uses, and between crops and other water uses.

Also as a consequence of economic growth, current rice cultivation areas are likely to be lost to urban expansion and land conversion to biofuels. Accordingly, sufficient production to meet future demand will have to come from smaller and smaller areas, particularly if diversification is to be possible while keeping rice prices affordable to poor consumers. In turn, this trend adds urgency to the need to improve productivity.

The rising costs of energy, human-induced environment and land degradation, water scarcity, and climate change all present challenges, some of which have been on the agenda for decades, others of which are new.[4] As Asia's population continues to grow and to urbanize at unprecedented rates, food insecurity in the region could worsen unless action is taken now. Asia must grow more food using less land, water, and labor, while overcoming new challenges from climate change.

Task Force Recommendations

The Asia Society/IRRI Task Force recognizes the enormous amount of effort from earlier studies that has gone into understanding and improving food security at the global, regional, national, and local levels. Without duplicating those efforts, this report outlines a series of actions that are needed to secure Asia's food security going forward, each of which falls into four main areas:

Recommendation 1: Raise and sustain the productivity of rice farmers in ways that conserve water, land, and energy-intensive inputs while also building resilience to the expected impacts of climate change.

[2] All rice consumption figures cited in this report refer to milled, or white, rice.
[3] UN Economic and Social Commission for Asia and the Pacific (UNESCAP), *Sustainable Agriculture and Food Security in the Asia Pacific* (Bangkok: UNESCAP, 2009), 40-42.
[4] Ibid., 59-72.

The Task Force urges increased investments to revitalize research and development efforts to raise the yield potential of rice, and more systematic inclusion of grain quality into rice breeding for specific target markets. The private sector's involvement in rice research and extension services that bring new techniques and technologies out into the field is needed to raise productivity growth. While public sector rice breeding and biotechnology research probably still has far more resources, private sector rice research has grown very rapidly from a small base in the last two decades. Larger and longer-term commitments to support research by the private sector on grand challenges and international public goods, as well as increased support of public sector research aimed at advancing high aggregate potential benefits, are crucial, especially given the lack of immediate commercial potential. Basic research is need in such areas as engineering of advanced photosynthesis mechanisms into rice, biological nitrogen fixation in rice, insect-virus interactions, and sustainability indicators for key ecosystem services.

On the basis of IRRI estimates, the Task Force recommends increased funding for the following six areas of research, which will cost approximately $60 million additional funding in 2010, rising to about $100 million additional funding per year by 2015:

- Strengthen and upgrade the rice breeding and research pipelines (including a nutrition focus);
- Accelerate research on the world's thousands of rice varieties;
- Develop a new generation of rice scientists and researchers for the public and private sectors;
- Bring about an agronomic revolution in Asian rice growing;
- Design new systems to integrate high-yield rice and production of other crops; and
- Improve postharvest technologies for rice

The Task Force strongly encourages public-private partnerships to carry out this research. To fund this research, the Task Force recommends an innovative new arrangement with similarities to a very successful funding mechanism developed in Brazil. There, the entire rice research and extension system in the state of Rio Grande do Sul is paid for by farmers, through a check-off system (20 cents per bag of rice produced = about $30 million per year). Rice yields have increased in the past 6-7 years at rates 4-5 times the world average, on over 1 million hectares of irrigated land. The system has three main advantages: research is focused on what farmers want, research funding benefits from increasing yields, and research funding (and the research itself) is independent from political fluctuations.

An alternative to the farmer check-off system, but with a similar philosophy, could work in Asia, where farm size tends to be very small. National commitments to fund rice research on the basis of the value of domestic rice production would certainly be a step forward, and public funding would signal a recognition that consumers benefit at least as much as farmers

from gains in rice productivity. This approach would need to allocate a small percentage of such a fund to the international institutions that carry out rice research, such as through the Consultative Group on International Agricultural Research (CGIAR). It is important that Asia participate significantly more in the funding of research on its basic food crops, especially rice. A production-based system would focus the incentives where they are most effective—long-run research on raising productivity in a sustainable fashion.

As a rough example of the possible sums involved, consider a base production of rice in Asia of about 400 million metric tons, worth about $300 per metric ton, for a total production value of $120 billion per year. A levy of 0.5% on the value of rice production would thus yield about $600 million per year to be allocated to rice research. Perhaps 10% of this should be devoted to the international centers conducting rice research, thus guaranteeing them about $60 million per year in regular funding (and leaving $540 million per year for in-country rice research programs). This would be considered "core" funding—unrestricted funding to be used for long-run research, provision of modern facilities, and regional training programs.

Recommendation 2: Improve the environment for rural development, including farm and non-farm activities at local, national, and regional levels, with renewed attention to how to stabilize domestic food economies.

The Task Force recognizes that stimulating rural development in a way that includes the landless and smallholder farmers is a huge task that is at the core of overall development strategies. It is also a task that in the past has often overlooked female farmers and workers. This report does not make specific recommendations on how any particular country should go about this task, but it does urge the global donor community to continue to put agricultural development back on its funding agenda. Higher agricultural productivity is the essential foundation for broader gains in the rural economy and from there to overall economic development. Specific recommendations on stabilizing food prices and establishing a more open trade regime for rice are presented because so little attention has been paid to these topics in the past two decades. The Task Force calls for the following measures:

- Invest in agricultural infrastructure and information systems;
- Reform the policy environment for food markets;
- Stabilize food prices;
- Build capacity of both male and female smallholder farmers to access markets;
- Connect macro policy to micro decision makers;
- Link agricultural development strategies to the rural poor; and
- Strengthen the rural non-farm economy.

Not only is rice risky to grow, it is risky to sell and trade. One way to lower risks is to increase the level of rice reserves, especially in the large Asian countries that have a deep interest in more stable rice prices. Larger reserves will be expensive to build and maintain, but the goal is not to use increased reserves to provide for growing demand for rice, but to cushion price shocks and help country policy makers have more confidence in using the world rice market—imports and exports—as a routine source of supply and demand.

An alternative proposal would be to establish a robust futures market for rice, perhaps in Singapore. Under normal circumstances, a robust and deep rice futures market should add substantial stability and transparency to formation of rice prices, which would help build confidence in the reliability of the world rice market. However, the successful development of a commodity futures market depends heavily on the legal structure of the contracts (and their perceived enforceability) and on access to modern financial markets to provide the underlying liquidity that makes a futures market useful to traders. Singapore seems a logical place for a rice futures market because it can satisfy these criteria.

Recommendation 3: Provide safety nets and more nutritious foods to the rural and urban poor so that they can lead productive lives even in the face of significant risks and vulnerabilities.

A rich portfolio of experiments to provide efficient and effective food safety nets has been underway for the past several decades, although only a few countries have managed to operate them at national scale. Conditional cash transfers seem to be evolving as best practice in this area, although in poor and remote regions without smoothly functioning food markets, there clearly remains a role for programs that physically deliver food to needy families.

The Task Force recommends that more of these ongoing experiments be brought to scale, but we recognize the extent to which unique circumstances, and funding opportunities, condition this recommendation. Still, if our goal is to make economic growth "pro-poor," we see a similar opportunity to make safety net activities "pro-growth." To do this, investments are needed in human capital in the form of better health and nutrition, as well as formal education. The returns to such investments, especially for the rural poor, are very high. They may not pay off directly in cash flow to the sponsors of the safety net programs themselves, but they clearly pay off to the society in the form of faster, and more equitable, economic growth. The Task Force calls for the following measures related to investments in health and nutrition:

- Design and implement cost-effective safety nets for food assistance for the rural and urban poor;
- Implement programs to prevent and treat undernutrition in emergency and development contexts; and
- Design programs that incorporate the special role of women in food security in Asia.

Recommendation 4: Provide regional public goods for sustainable food security in Asia.

To ensure that activities to provide the public goods needed in the three crucial recommendations above are widely communicated and, to the extent possible, effectively coordinated, the Task Force recommends that a Center for the Coordination of Food Security Activities in Asia be established within an already existing Asia-based institution—the Regional Office for Asia and the Pacific of FAO and the Asian Development Bank are obvious possibilities. The first step towards establishing this Center would be to assess existing food security-related efforts being led by regional and sub-regional groups, examine how these services are being provided, and identify the constraints and gaps in their efforts. As part of this assessment, regional policy makers should initiate discussion forums with private sector leaders, non-governmental organizations, and other key stakeholders on the effective provisioning of regional public goods for food security.

Following this assessment, the Center should be equipped with the resources to access timely information on food production, trade and prices, and consumption (and would make this information widely and freely available); monitor policy and program initiatives at the country and regional level (and issue regular policy briefs and updates); and conduct its own evaluations of the impact and cost effectiveness of food security strategies in the region. A specific part of its mandate would be to document the systemic nature of long-run food security challenges in Asia and to identify appropriate systemic approaches to these challenges to strengthen or complement existing efforts in the region. The Center would need high-level links to research centers in the region that are engaged in analysis of food security issues. These links could be mediated via regular exchanges of analysts and scholars, which could also be used to support regional training programs in food security.

Financial Dimensions

New money is going to be needed every year to achieve sustainable food security in Asia. The United Nations estimates that an additional $40 billion dollars per year would be needed—on top of the $80 billion currently being spent on agricultural development, poverty reduction, and food security—to eliminate hunger and poverty in Asia by 2050. An additional $12 billion per year will be needed to scale up programs to eliminate malnutrition. At a more focused level, IRRI estimates that an annual investment of $120 million between 2010 and 2030 could increase rice productivity by 8.5% (above "business as usual" trends) over the next 25 years, which could lower the poverty rate in Asia by 15% and the hunger rate by 20%. There are no other visible investments with that kind of impact on hunger and poverty.

Where will this money come from? The world food crisis of 2007-08 has clearly put food security back on the agenda of the broader donor community. Major commitments of new funding have been made, but no careful analysis has yet been done of when the committed funding is likely to be available, on what terms, and for what purposes. Recent "food security investment forums" at the country level have begun to specify in considerable detail the likely resources needed, but only Bangladesh has so far managed to produce a

detailed plan of action and begun to raise the resources needed to fund it. On the basis of this plan, Bangladesh was the first country in Asia to qualify for funding from the new Global Agriculture and Food Security Program (GASFP). Finding ways to make the GASFP process flexible, efficient, and accessible should be a high priority.

Developing strong partnerships with the private sector will bring about better understanding of this important sector's investment plans in areas that affect food security, from input technologies to development of modern supply chains, to food technologies that change the range of products available to consumers. In aggregate, the entire agribusiness system that provisions the global food economy is the largest industry in the world. Virtually all of the funding for this system comes, of course, from food consumers. Other funding sources—foundations, international financial institutions, philanthropic individuals—will be crucial for moving forward the food security agenda, but it is important to realize where this funding fits in the larger global food economy.

Finally, it is worth re-emphasizing the crucial need for individual countries to raise enough revenues domestically to fund their own rice research activities, with modest contributions to global agricultural research as a public good. Country-based funding will also provide the great majority of support for safety nets, school feeding programs, and initiatives to bring women into a more prominent role in providing food security at the household, village, national, and global levels.

The Nature of the Challenge

Incredible progress has been made since the widespread fears in the 1960s that Asia had become a "basket case," beyond the capacity of the world's rich countries to support with food aid. The scientific, financial, and institutional responses to the food crises in the 1960s and 1970s that generated this pessimism are relevant today and help build an understanding of the magnitude of resources needed to meet even larger challenges currently facing Asian societies.

The institutional response to food crises in the 1960s and 1970s was particularly important, as it stimulated the scientific and financial responses that helped to solve the problems at the time. As President of the World Bank in the 1970s, Robert McNamara led the World Bank into a substantial expansion of its programs to raise agricultural productivity and stimulate rural development. The World Food Conference in 1976 made commitments to end hunger. Significant increases in foreign assistance for agricultural development, coupled with the new seed technologies made available from the International Rice Research Institute (IRRI) and the International Maize and Wheat Improvement Center (CIMMYT), both of which were established through the philanthropy of the Rockefeller and Ford Foundations, resulted in rapidly rising rice and wheat yields; improvements in food intake throughout most of Asia; sharply falling poverty rates, especially in Indonesia after 1970 and China after 1978; and rapid, pro-poor economic growth stimulated by agriculture. The share of agriculture in foreign assistance was large and was managed by a cohort of agricultural specialists who had field experience and access to policy makers.

Making rice available and affordable to all consumers is the foundation of Asian food security. Rice research is the single largest documented source of agricultural research benefits in the developing world. Annual economic benefits from rice productivity-enhancing research exceed $19.5 billion.[5] By the late 1990s, annual gains in Asia from the adoption of modern varieties of rice from IRRI, largely through the national systems, were $10.8 billion, nearly 150 times the combined annual investment in rice research by IRRI and national systems. This research has also spared 13 million hectares of natural ecosystems from being brought under cultivation, with attendant environmental benefits.

Moreover, rice research is the source of roughly half of all documented benefits stemming from the efforts of the Consultative Group on International Agricultural Research (CGIAR) system, even though rice research has usually constituted less than 10% of CGIAR expenditures.[6] As the agricultural product associated with the largest proportion

[5] Sum of Asian estimates adjusted to 2010 prices; see Robert E. Evenson and Douglas Gollin, eds., *Crop Variety Improvement and Its Effect on Productivity: The Impact of International Agricultural Research* (Wallingford, UK: CAB International, 2003). For Latin America estimates, see Louis Roberto Sanint and Stanley Wood, "Impact of Rice Research in Latin America and the Caribbean During the Past Three Decades" in *Impact of Rice Research*, ed. Prabhu L. Pingali and Mahabub Hossein (Los Baños, Philippines: International Rice Research Institute, 1998), 405-28.

[6] David A. Raitzer and Timothy G. Kelley, "Benefit-Cost Meta-Analysis of Investment in the International Agricultural Research Centers of the CGIAR," *Agricultural Systems* 96, nos. 1-3 (2008): 108-23.

of the income, expenditures, and food intake of poor populations, rice must be a core focus of agricultural research for poverty reduction and food security on a sustainable basis, especially in Asia.

Over the past half-century, there has been enormous progress in raising the productivity of Asia's rice farmers, ensuring that high quality and safe rice is available to consumers, and understanding the environmental challenges to sustaining these achievements in the years to come. One simple but telling example of progress is the rise in rice consumption per capita in the poorest quintile of India's rural households—arguably among Asia's most food insecure families—from 0.90 kilograms per week in 1983 (all of India) to 1.43 kilograms per week in 2004-05.[7] This represented a substantial increase in food intake for these poor households, but clearly much more is needed.

Persisting Poverty and Hunger in Asia

Achieving and sustaining food security in Asia is a daunting task. China and India alone account for 42% of the world's hungry.[8] The Food and Agriculture Organization warns that with the global population expected to grow to more than 9 billion people by 2050, food production will need to increase by 70% to ensure food security worldwide in the decades to come. The agricultural sector in developing countries holds the greatest potential to meet these food production requirements, but investments in this sector will need to increase by at least 50% in order to prevent worldwide food insecurity by 2050.[9]

Against this backdrop, global efforts to reach development targets—established following the 1996 World Food Summit and through the Millennium Development Goals of 2000 and aimed at reducing by half the proportion of hungry people in Asia—remain an elusive goal.[10] While the Group of Eight pledged $20 billion in July 2009 over the next 3 years to support agricultural development in developing countries, this is far short of the $44 billion the UN says is needed annually to prevent food insecurity in the coming decades. Indeed, official development assistance for agriculture and rural development in developing countries (as a share of total assistance) has decreased from 17% in 1980 to 3.8% in 2006. Today, assistance to these sectors is only at 5%.[11]

Much hunger and poverty remains in Asia (as in the rest of the world). Rice plays a big role in this poverty, both as the food staple of the poor, and as a source of income for many of the region's most vulnerable farmers. This remaining poverty in "lagging regions" is the source of much research interest and policy focus; for example, the Bill and Melinda Gates Foundation will hold a "convening" on this topic in late November 2010 to explore the

[7] C. Peter Timmer, Steven Block, and David Dawe, "The Long-Run Dynamics of Rice Consumption: 1960-2050," prepared for the IRRI 50th Anniversary Conference volume (forthcoming 2010).
[8] Food and Agriculture Organization (FAO), The State of Food Insecurity in the World 2008 (Rome: FAO, 2008), 15; UNESCAP, *Sustainable Agriculture and Food Security in the Asia Pacific* (Bangkok: UNESCAP, 2009), 15.
[9] FAO, "Feeding the World, Eradicating Hunger" (WSFS 2009/INF/2), http://www.fao.org/fileadmin/templates/wsfs/Summit/WSFS_Issues_papers/WSFS_Background_paper_Feeding_the_world.pdf.
[10] Following the 1996 World Food Summit, countries agreed to cut by half the *number* of hungry people worldwide. The Millennium Development Goals of 2000 set a target of halving the *proportion* of people struggling with hunger worldwide.
[11] FAO, "Feeding the World, Eradicating Hunger."

issues and possible resource initiatives that could push forward understanding and action. But the depth of continuing hunger and poverty in Asia should not be underestimated: at least two-thirds of the world's hungry live between North Korea and Kazakhstan, and most of them are primarily rice consumers.

Raising productivity of rice cultivation could have a huge impact on reducing this remaining poverty. An assessment of the impact on global poverty and hunger attributable to a production increase of 8.5% over the next 25 years (above current trends)—equivalent to an average of 15 additional kilograms per hectare per year additional yield growth over the period—shows that it would result in a 10% to 23% rice price reduction in Asian countries and 7% to 10% reduction in major Latin American and African markets. These price reductions would have very substantial poverty reduction effects in Asia, as shown by the following results of the assessment:

- Expenditures on rice by those under the $1.25 per day poverty line would decline by $9.5 billion annually in Asia (holding consumption constant);
- Counting those reductions as income gains means that 133 million Asian people would be lifted above the $1.25 poverty line, reducing the number of poor by 15%;
- As a result of increased availability and reduced prices, 107 million undernourished Asians would reach caloric sufficiency, reducing hunger by 20%;
- With reduced rice prices, households could spend a greater share of their food and overall budget on non-grain foods, potentially leading to more diversified diets and higher intakes of essential vitamins and minerals;[12]
- 3 million hectares less land would be used for rice (1.5 million hectares of averted expansion plus 1.5 million hectares of reduced area), reducing pressure on natural ecosystems.

These impressive numbers arise from an aggregate global 25-year investment of $3 billion, or $23 per person lifted above the poverty line. Very few other development investments have similar efficacy in poverty eradication. Large benefits to the poor can also be expected in Africa and Latin America.[13]

Other analyses have shown that productivity-enhancing research on rice is the largest expected source of future impact for the poor among focal crops for agricultural research. For example, analysts in the World Bank's Development Research Group, comparing a common rate of productivity growth across commodities, found that productivity growth

[12] Harriet Torlesse, Lynnda Kiess, and Martin Bloem, "Association of Household Rice Expenditure with Child Nutritional Status Indicates a Role for Macroeconomic Food Policy in Combating Malnutrition," *The Journal of Nutrition*, 133 (2003): 1320-25.

[13] IRRI, "Appendix 1. Ex ante assessment of the potential impact of GRiSP," in *A Global Rice Science Partnership (GRiSP): Proposal for a Consortium Research Program* (2010), 70-73, http://www.s.affrc.go.jp/docs/workshop/pdf/100624_grisp_proposal_rev2.pdf.

for rice has more than twice the global poverty reduction potential of any other agricultural product.[14] Similarly, in a subregional analysis for Southeast Asia, the Global Conference on Agricultural Research for Development concluded that productivity enhancement for rice had nearly as much poverty reduction potential as all other agricultural products combined.[15]

While increasing rice productivity has been associated with significant falls in poverty in parts of Asia, there remains a paradox in South Asia with regard to consequent improvement in other outcomes. Of the 178 million stunted children under 5 years of age worldwide, 112 million of them live in Asia—the majority in South Asia—as do the highest numbers of underweight and wasted children. India, for example, secured significant reductions in poverty, moved from rice deficits to rice surpluses, and now has a per capita income higher than in most parts of Sub-Saharan Africa, but it is home to 39% of the world's underweight children. The prevalence of underweight children in India is almost 20 times higher than in a healthy well-nourished population, and almost twice as high as that found in Sub-Saharan Africa.[16] Similarly, in Bangladesh, poverty fell 9 percentage points in the first half of this decade, the country was all but self-sufficient in rice, and there were no significant disasters, and yet by 2007 child wasting rates had increased from 10% in 2000 to 16%, above the 15% threshold that constitutes an emergency. Wasted children are nine times more likely to die than non-wasted children.

Many believe that the status of women in South Asia is a barrier to the translation of poverty reduction and increased rice availability into improvements in nutritional status. If women and men had the same status in South Asia, the prevalence of underweight children would decline by 13 percentage points, equivalent to about 13.4 million children. If women's and men's status were equalized in Sub-Saharan Africa the impact would be just a 3 percentage point fall.[17] In many parts of South Asia, women are not responsible for food purchases, because of restrictions on their mobility outside the homestead. Such restrictions may also limit the effectiveness of conditional cash transfer programs—successful safety net interventions in other parts of the world—both because of the conditioning behavior and the widespread finding that women are more likely than men to spend income under their control on food, health care, education, and children's goods.

Simultaneously, a growing share of the South Asian population suffers from overweight and related illnesses. The lack of a diversified diet and poor quality of diets for children under 2 years of age and among pregnant and lactating women in poor households, poor feeding

[14] Marcos Ivanic and Will Martin, "Promoting Global Agricultural Growth and Poverty Reduction," prepared for Conference of the Australian Agricultural and Resource Economics Society, Adelaide, Australia, February 10-12, 2010.
[15] David A. Raitzer, Johannes Roseboom, Mywish K. Maredia, Zenaida Huelgas, and Maria Isabel Ferino, "Prioritizing the Agricultural Research Agenda for Southeast Asia: Refocusing Investments to Benefit the Poor," prepared for the Southeast Asia Subregional Review of the Global Conference on Agricultural Research for Development, Montpellier, France, March 28-31, 2010.
[16] Fred Arnold, Sulabha Parasuraman, P. Arokiasamy, and Monica Kothari, *Nutrition in India: National Family Health Survey (NFHS-3), India*, 2005-06, (Mumbai: Institute for Population Sciences; Calverton, MD: ICF Macro, 2009).
[17] Lisa C. Smith, Usha Ramakrishnan, Aida Ndiaye, Lawrence James Haddad, and Reynaldo Martorell, "The Importance of Women's Status for Child Nutrition in Developing Countries," Research Report 131 (Washington, DC: International Food Policy Research Institute, 2003).

practices, and limited access to quality health-related services are the major underlying causes for undernutrition. Poor eating practices are also at the heart of the problem of overnutrition.

Child undernutrition is a major obstacle to further development in the region. In addition to equitable economic growth and development, a serious food security response needs to emphasize investments in direct and indirect nutrition approaches. Direct nutrition interventions with demonstrated effectiveness need to be taken to scale in countries with high rates of undernutrition. Indirect interventions in multiple sectors (e.g., health, agriculture, education, and social protection) that tackle the economic, political, social, and cultural underlying and basic causes of undernutrition are also needed, with aims of increasing access to food, improving the quality of the diet in terms of micronutrients, and increasing use of health care and education. Incorporating women's empowerment and agency and addressing gender inequality is also essential in tackling undernutrition in multiple sectors.

Accelerating yield growth is the main mechanism for expanding food production. Growth in area harvested and further intensification through multiple cropping will be limited by reductions in access to water supplies for the agricultural sector, and losses in cropland through urbanization and poor land management. IRRI is at the forefront of efforts to address the challenges associated with accelerating growth in rice yields through the creation of a Global Rice Science Partnership (GRiSP) under the Mega Program of CGIAR.[18] The analysis and proposals related to rice productivity in this Task Force report draw from this IRRI proposal to establish GRiSP and from accompanying support documents.

Sustaining the gains will not be easy. The environmental consequences of high-yield agriculture are a major challenge to researchers, who need to find crop technologies that produce fewer greenhouse gases, that use less water per kilogram of edible produce, and that improve the quality and health of soils to ensure long-run productivity. Moreover, current environmental challenges facing rice farmers in non-core areas—drought, salinity, flooding, heat, and cold—will all be exacerbated by climate change. Therefore, current work—significantly underfunded but underway—provides rice scientists clear lenses into the problems of climate change. This can be a quite technical discussion, but one of the key messages already clear is that just "standing still" in terms of productivity is an enormous challenge. Moving the rice productivity frontier outward will require an order of magnitude increase in resources available to rice scientists across the globe.

[18] See International Rice Research Institute (IRRI), "A Global Rice Science Partnership (GRiSP): Proposal for a Consortium Research Program," Revised Draft, 25 June 2010. The research consortium would include IRRI, International Center for Tropical Agriculture (CIAT), and AfricaRice, joined by Agricultural Research for Development, International Relief and Development, Japan International Research Center for Agricultural Sciences, and over 450 other partners.

Measures Underway in the International Community

This section reviews the major efforts underway in the international community and among donor organizations to advance sustainable food security in Asia. Many of these activities resulted in financial pledges by individual countries and the multilateral donor community, most of which have not been translated into action programs. One purpose of this Task Force report is to urge governments to fulfill those pledges.

The Millennium Development Goals (2000)

The 2000 Millennium Development Goals (MDGs) are at the heart of global efforts to address extreme poverty across the world. Adopted by all 191 members of the United Nations, the eight goals outlined in the MDGs focus on a comprehensive set of sectors, including hunger and poverty, universal education, gender equality, child mortality, maternal health, infectious diseases, and environmental sustainability. Through 21 quantifiable and time-bound targets, countries agreed to meet a rigorous set of development targets by 2015 through public and private sector financing and projects.[19]

The 1996 World Food Summit in Rome established the basis for Goal 1 of the MDGs, which seeks to eradicate hunger and poverty. Goal 1 of the MDGs clearly establishes the link between food insecurity and persistent poverty. The 1996 Summit defined food security as "when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life."[20] Goal 1 contains three targets and uses 1990 as the baseline indicator. The first target commits countries to halving the proportion of people living in poverty (defined as those living on less than $1.25 per day) by 2015.[21] The second target addresses the importance of achieving full and productive employment, particularly for women and youth. The third target seeks to halve the proportion of people suffering from hunger by 2015, using the prevalence of children under 5 years old who are underweight and proportion of a population below minimum dietary requirements as measures.[22]

In the 10 years since the MDGs were established, progress in Asia towards achieving the Goal 1 targets has been mixed. In East Asia, for example, the proportion of people living in poverty has decreased from 60% in 1990 to an impressive 16% in 2005, well ahead of the target. Much of this success can be attributed to impressive economic growth in China, which helped to lift 475 million people out of poverty. In Southeast Asia, the

[19] For complete overview of the MDGs, see http://www.un.org/millenniumgoals.
[20] See http://www.fao.org/wfs/index_en.htm for information and documents related to the 1996 World Food Summit.
[21] In 2008, the poverty line was raised from $1.00/day to $1.25/day. For an explanation, see UNESCAP, ADB, and UN Development Programme (UNDP), *Achieving the Millennium Development Goals in an Era of Global Uncertainty: Asia-Pacific Regional Report 2009/10* (Bangkok: UNESCAP, 2010), 10.
[22] Data for underweight children is drawn from the UN Children's Fund and World Health Organization. Data for dietary requirements are drawn from the FAO.

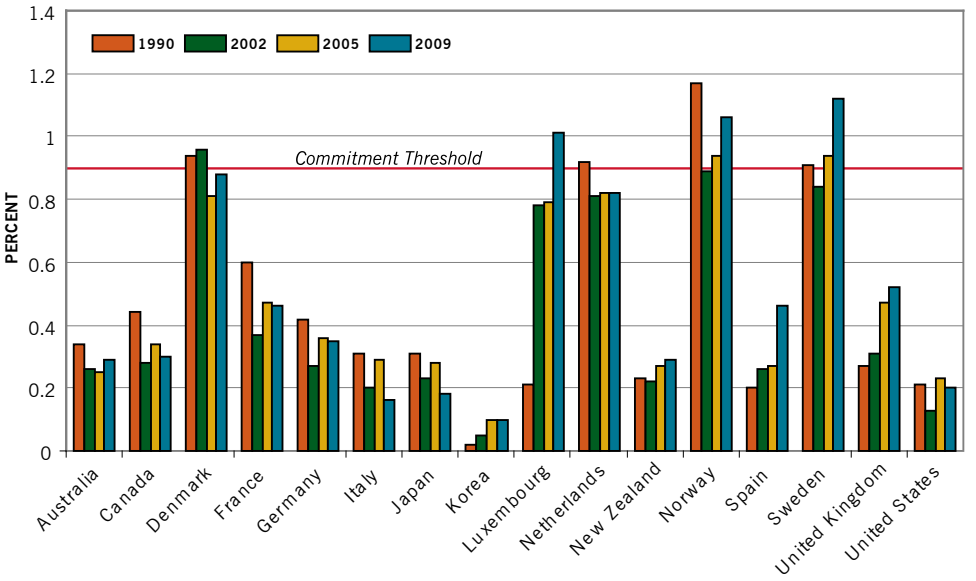
proportion of people living in poverty has been effectively halved from 39% in 1990 to 19% in 2005. Progress in South Asia remains slow, however, with 39% of the population still living on $1.25 per day in 2005, compared with 49% in 1990.[23] Moreover, while the proportion of unemployed living on less than $1.25 per day has decreased substantially as a result of rapid development in Asia, the global recession has continued to weaken labor market conditions. In East Asia, for example, the proportion of unemployed decreased from 52% in 1990 to 19% in 2008, but in 2009 increased again to 21%.[24]

Progress in reducing hunger has been decidedly less optimistic, and the global food crisis in 2007-08 contributed to a worsening of the situation. Across Asia, the proportion of hungry people declined from 20% since 1990-92 to 16% in 2004-06, but the global food crisis pushed the proportion of hungry people up to 17% in 2008. Moreover, Asia continues to struggle with reducing child malnutrition rates, with the proportion of children under five who are underweight at 26% in 2007, only a 5% reduction since 1990, a result largely driven by the poor performance of South Asia.[25] As a whole, Asia continues to struggle or will fall short in meeting the targets set out in Goal 1 of the MDGs. One out of seven people in Asia continue to suffer from hunger and malnutrition, and even more remain vulnerable to shocks in international food markets. Anemia, Vitamin A deficiency, and other vitamin and mineral deficiencies are also very high among women and children.

With only 5 years remaining to achieve the development targets set out in the MDGs, securing and sustaining adequate financing continues to be an ongoing challenge. The 2002 Monterrey Consensus committed developed countries to an increase in their official development assistance to a peak of 0.70% of gross national product for developing countries and 0.15% to 0.20% of gross national product for least developed countries by 2015. The Monterrey Consensus also obligates developing countries to improvements in governance and an increase in their national budgets towards development priorities.[26] As of 2008, the average proportion of gross national product devoted to official development assistance among developed countries was at approximately 0.30% for developing countries and 0.80% for least developed countries, virtually no change from 1990 levels. (*See Figure 1*). In terms of real dollars, development assistance reached a record $120 billion in 2008, with the United States being the single largest aid source with $26.8 billion disbursed in 2008.[27] Nevertheless, the United Nations estimated in 2005 that minimum annual investments rising to $189 to $195 billion in 2015 will be needed if the MDGs are to be met. This amount represents an equivalent to 0.54% of average gross national product from donor countries in 2015.[28]

[23] United Nations, *The Millennium Development Goals Report: 2010* (New York: UN Department of Economic and Social Affairs, 2009), 6.
[24] Ibid., 9-10.
[25] Ibid., 13-14.
[26] The full text of the 2002 Monterrey Consensus can be accessed here: http://www.un.org/esa/ffd.
[27] United Nations, *The Millennium Development Goals Report: 2010*, 66-68. The only countries to reach or exceed this commitment are Denmark, Luxembourg, the Netherlands, Norway, and Sweden.
[28] UN Millennium Project, Investing in Development: A Practical Plan to Achieve the Millennium Development Goals: Overview (New York: United Nations, 2005), 56-58.

Figure 1: Official Development Assistance from 1990-2009 (as percent of gross national product)[29]



As the foregoing survey makes clear, meeting the Goal 1 targets of eradicating hunger and poverty—as well as the MDGs as a whole—will require increased and sustained commitments by donor countries over the next 5 years. The food crisis of 2007-08 further brought into stark relief the ongoing challenges in eradicating poverty and hunger and the urgency of commitment gaps under Goal 1 of the MDGs. Since 1980, the proportion of development assistance for agriculture and rural development in developing countries has decreased from 17% to 3.8% in 2006. Today, assistance to these sectors is only at approximately 5%. With the global population expected to grow to more than 9 billion people by the year 2050, the United Nations estimates that $44 billion will be needed annually to support agricultural development aimed at reducing poverty and hunger long after the MDGs deadline of 2015. Confronting malnutrition in developing countries will require an annual investment of approximately $12 billion.[30]

UN High-Level Task Force on the Global Food Security Crisis

In April 2008, UN Secretary-General Ban Ki-moon established the High-Level Task Force on the Global Food Security Crisis, composed of 22 key departments, funds, and agencies of the United Nations. The Task Force was organized to coordinate a response to the food crisis as well as prevent a reversal of gains made towards achieving Goal 1 of the

[29] Organization for Economic Cooperation and Development, Stat Extracts, http://stats.oecd.org/index.aspx (accessed June 10, 2010).
[30] FAO, "Feeding the World, Eradicating Hunger."

MDGs. The UN Task Force issued a Comprehensive Framework for Action that presented a two-track plan. The first track seeks to address the immediate needs stemming from the food crisis, particularly the needs of vulnerable populations. These include:

- Providing emergency food assistance and improving access to nutrition and safety nets for those most affected by the food crisis. Additionally, the UN Task Force called for the free flow of humanitarian food aid and exploring the possible establishment of "actual or virtual humanitarian food reserves";
- Increasing food production among smallholder farms through the provision of critical inputs (seeds, fertilizer, etc.), rehabilitation of infrastructure, enhancing postharvest technology, and improving access to markets;
- Adjusting trade and tax policy to avoid price distortions in the international and domestic food market and to minimize import and export restrictions on foodstuffs;
- Managing macroeconomic implications of the food crisis and the response to it by instituting sound financial management practices to prevent inflation, rising balance-of-payment deficits, and low levels of foreign reserves, among others.

The second track contains measures to improve long-term resilience in the food market and global food security. These include:

- Expanding social protection schemes and food assistance programs in developing countries to ensure that citizens can cope with and recover from price shocks and avoid nutrient deficiencies;
- Sustaining smallholder farmer food production through increased public, private, and donor investments; better natural resources management; improvements in rural infrastructure and technological research; and increased financial services;
- Improving the international market for food through reducing agricultural subsidies, enhancing free trade, limiting speculation in futures and commodity markets, and establishing a system for food stocks;
- Developing an international consensus on the production of biofuels from food crops that takes into account its impacts on food security, climate change, energy security, and environmental sustainability.[31]

According to the United Nations, the UN Task Force mobilized direct support for 20% of the world's hungry people in 2008 through targeted programs totaling approximately $5.3 billion in additional funding secured and allocated for short-term responses. An additional $1.1 billion and technical support were provided to support smallholder farmer

[31] See United Nations, *Comprehensive Framework for Action: High-Level Task Force on the Global Food Security Crisis* (New York: United Nations, 2008).

food production, benefiting as much as 5% of the world's 2 billion smallholder farming families. The UN Task Force also coordinated funding and guidance from international financial institutions into countries most affected by the food crisis to improve their micro- and macroeconomic responses. Additionally, a number of efforts were made to address the underlying drivers of the food crisis. For example, the World Bank increased its support for agricultural and rural development through loans, credits, and grants totaling $7.3 billion (up from $4.1 billion per year over the past 3 years) by the end of June 2009. The World Food Program spent $1.1 billion on food from developing countries to help spur increased agricultural production in 2008.[32] In short, the UN Task Force is one of the most comprehensive and coordinated responses ever undertaken by the United Nations to address specific issues related to hunger and poverty.

The Group of Eight and Group of Twenty

The July 2009 Group of Eight (G8) Summit in L'Aquila, Italy, produced one of the most comprehensive efforts to address global food insecurity in recent years. Recognizing the disastrous impact that the 2007-08 food crisis and the global recession had on progress towards achieving Goal 1 of the MDGs, the G8 agreed to a common set of principles to meet the challenges associated with global food insecurity, for example by supporting country-level programs; promoting a comprehensive approach that addresses issues including trade, sustainable resources, and the needs of vulnerable populations; and coordinating responses through multilateral organizations. Collectively, the G8 committed to providing $20 billion over 3 years to support these principles to advance sustainable agriculture and the strengthening of emergency food assistance across the world. The L'Aquila Joint Statement on Food Security was endorsed by 26 countries and 14 international organizations and firmly established a Global Partnership for Agriculture and Food Security, which had been proposed since late 2008. The Partnership promotes the broadest participation possible in assessing and formulating agricultural and food security policy—including participation by government, international organizations, civil society, and the private sector—and serves as a platform to coordinate an international response to hunger.[33]

At the September 2009 Group of Twenty (G20) Summit, the L'Aquila Joint Statement was further reinforced with an agreement to establish the Global Agriculture and Food Security Program, which would oversee and coordinate the delivery of the $20 billion pledged earlier in the year. Implemented through the World Bank, a fund would be established whereby donors could channel their contributions either to public or private sector projects. The aim of the Program's funding is targeted at a comprehensive set of objectives, such as improving agricultural productivity through developing high-yield crop varieties and improved water management, linking farmers to markets, providing emergency nutritional assistance, and developing technical assistance and education

[32] United Nations, *High Level Task Force on the Global Food Security Crisis: Progress Report, April 2008-October 2009* (New York: United Nations, 2009).
[33] To read the L'Aquila Joint Statement on Food Security, see http://www.g8italia2009.it.

programs.[34] In April 2010, the Program was officially launched with an initial contribution totaling $880 million. The United States contributed the largest amount at $475 million, with additional contributions from Canada, Spain, the Republic of Korea, and the Bill and Melinda Gates Foundation.

The United States, historically the largest contributor to food security assistance worldwide, both bilaterally and internationally, has been a leader in times of crisis by providing short-term needs through food aid.[35] In recent years, however, the share of U.S. development assistance going towards long-term agriculture development has begun to steadily rise.[36] In 2007, for example, the United States accounted for 39% of all global food aid. It also led the global response to the 2007 food crisis, and in 2007 and 2008 the United States allocated over $5.5 billion to fight world hunger, including $1.8 billion of new resources going towards humanitarian response, increasing productivity, addressing infrastructure constraints, and support for trade liberalization and agricultural technology.[37] In May 2010, the United States introduced the Feed the Future initiative, which represented a follow through on its pledges made at the G20 summit in September 2009, and also signaled a renewed commitment towards helping to meet the long-term objectives of poverty and hunger reduction outlined in Goal 1 of the MDGs. The initiative provides $3.5 billion over the next 3 years to support agricultural development in 20 developing countries, four of which are in Asia: Bangladesh, Cambodia, Nepal, and Tajikistan.[38] The goals of the initiative include improving agricultural production; expanding markets and trade; enhancing resilience to emergencies among rural communities; and preventing and treating undernutrition, particularly among vulnerable populations such as women, adolescent girls, and children. This initiative remains the largest commitment towards agricultural development from a G20 country since the L'Aquila Joint Statement.

The Rome Declaration 2009

In November 2009, the UN Food and Agriculture Organization convened world leaders for the World Summit on Food Security in Rome. Organizers of the Summit announced that more than one billion people are currently living in hunger across

[34] World Bank, *The Global Agriculture and Food Security Program: Questions and Answers* (Washington, DC: World Bank, 2010).

[35] United States Government Accountability Office, *Global Food Security: U.S. Agencies Progressing on Governmentwide Strategy, but Approach Faces Several Vulnerabilities*, GAO-10-352 (Washington, DC: GAO, 2010).

[36] The share of U.S. development assistance going towards long-term agriculture development has declined from a high of 25% in 1980 to just 1% in 2003. See The Chicago Council on Global Affairs, *Renewing American Leadership in the Fight Against Global Hunger and Poverty* (Chicago: Chicago Council on Global Affairs, 2009). The report urges an increase in U.S. development assistance for agriculture in order to signal a renewed commitment to the developing world, while helping to prevent conflicts or state failure as a result of chronic hunger and poverty. The report focuses largely on U.S. assistance for agriculture in Sub-Saharan Africa and South Asia.

[37] See USAID, "USAID Press Statement on World Food Day," October 16, 2008. Also see http://www.usaid.gov/our_work/humanitarian_assistance/foodcrisis/.

[38] U.S. Department of State, *Feed the Future Guide* (Washington, DC, 2010). In Africa: Ethiopia, Ghana, Kenya, Liberia, Mali, Malawi, Mozambique, Rwanda, Senegal, Tanzania, Uganda, and Zambia. In Latin American and the Caribbean: Guatemala, Haiti, Honduras, and Nicaragua.

the world—exacerbated by the global food crisis—and that this "tragic achievement" threatened to derail all progress towards meeting Goal 1 of the MDGs. With the world's population expected to exceed 9 billion people by 2050, the Summit declaration affirmed a need to increase agricultural output by 70% in 40 years to feed the global population, and urged countries to reverse a 20-year decline in investment into the agricultural sector. In developing countries, for example, annual investments into agriculture between 1997 and 2007 were estimated at approximately $142 billion (2009 prices). To meet growing demand for food, developing countries would need to raise total investments by 47% to $209 billion per year.[39]

The Summit outcome, or the "Rome Declaration," outlined five principals for sustainable global food security for world governments to follow to address these challenges:

- Prioritize national budgets and fund investments in high-impact, results-oriented national food security programs;
- Promote coordination at the national, regional, and international levels on governance and resource allocation for food security to avoid duplication and fill existing resource gaps;
- Commit to both short- and long-term programs directed at eradicating the root causes of poverty and hunger;
- Support a strong role for multilateral institutions by improving their efficiency, responsiveness, coordination, and effectiveness; and
- Ensure prompt and reliable funding and investments into agriculture, food security, and nutrition programs.[40]

The 2009 Summit reinforced the issue of food insecurity as a priority on the international agenda, but it did not produce concrete financial commitments for agricultural development.

Association of Southeast Asian Nations

The Association of Southeast Asian Nations (ASEAN) seeks to reinforce existing commitments to address poverty and hunger at the international level, especially the targets set out in Goal 1 of the MDGs. The most comprehensive articulation of ASEAN's position on food security and agricultural development is contained in the Strategic Plan of Action on ASEAN Cooperation in Food, Agriculture and Forestry, which grew out of the 1997 Hanoi Plan of Action to establish a "concert" of Southeast Asian nations by 2020.[41] Implemented as 6-year plans (1998-2004 and 2004-10), the Plan of Action offers practical targets and programs for ASEAN member states in the areas of data sharing,

[39] FAO, "Feeding the World, Eradicating Hunger.
[40] FAO, "Declaration of the World Summit on Food Security" (WSFS 2009/2), http://www.fao.org/fileadmin/templates/wsfs/Summit/Docs/Final_Declaration/WSFS09_Declaration.pdf.

improved access to pricing information in food markets, research and development, trade, sharing of agricultural technology, private sector engagement, and conservation of natural resources, among many others.[42] Largely considered a success story in regional cooperation, the Plan of Action continues to guide ASEAN efforts towards enhanced food security and competitiveness of agricultural and forestry products from the region in the global market.[43]

Following the 2007-08 food crisis, ASEAN member states in 2009 renewed their efforts through an Integrated Food Security Framework and a Strategic Plan of Action on Food Security to address long-term food security issues in the region. Both the Framework and Plan of Action identified rice, maize, soybeans, sugar, and cassava as priority commodities in achieving food security and outlined six key areas of strategic focus for ASEAN member states to develop: food security systems (e.g., assistance programs, reserves), food market and trade, information, productivity, public investment, and measures to address future impacts on food security stemming from biofuels and climate change. The Strategic Plan of Action contains a comprehensive list of measures ASEAN member states would implement between 2009 and 2013 to achieve the goals set out in the six areas of focus.[44]

ASEAN's effort to establish a regional rice reserve stock as a response to food emergencies has been one of the most innovative approaches to addressing food insecurity in the region. The initiative to create a regionally coordinated reserve stock began in 1979 when countries signed the Agreement on the ASEAN Food Security Reserve. The Agreement obligated countries to set aside a nationally controlled Emergency Rice Reserve and established a Food Security Reserve Board to oversee a total initial rice allocation of 50,000 metric tons. The reserves would be activated only in emergencies when rice imports are insufficient to meet domestic food shortages, with price, terms, and conditions of distribution negotiated directly between countries. In 1997, stock levels were raised to 67,000 total metric tons of rice, with Thailand and Vietnam holding the largest stock at 15,000 and 14,000 metric tons respectively. By 2004, the rice reserve stock rose again to 87,000 metric tons with the inclusion of new members into ASEAN, but the scheme never gained the needed traction to be a reliable system for rice emergencies in the region. Even if the reserve reached its full capacity, the rice available equaled less than half of the daily consumption needs of all ASEAN countries and represented only 0.1% of overall rice demand in the region.[45]

[41] To read the Association of Southeast Asian Nations Vision 2020 declaration, go to http://www.aseansec.org/1814.htm.
[42] To read the Strategic Plan of Action on ASEAN Cooperation in Food, Agriculture and Forestry, see http://www.aseansec.org/6218.htm.
[43] International Trade Strategies Pty Ltd., "A Background Paper for the Strategic Plan of Action on ASEAN Cooperation in Food and Agriculture (2005-2010)," REPSF Project No. 03/004 (July 2004), http://www.ausaid.gov.au/publications/pdf/asean_food.pdf.
[44] To read the ASEAN Integrated Food Security Framework and Strategic Plan of Action on Food Security in the ASEAN Region, see http://www.aseansec.org/22338.pdf.
[45] Japan Ministry of Agriculture, Forestry and Fisheries, "Towards a World Free of Starvation and Poverty: Introductory Information on the International Food Stockholding Scheme and East Asia Emergency Rice Reserve," http://www.maff.go.jp/e/pdf/eaerr.pdf.

Given the shortcomings of the ASEAN Food Security Reserve, a renewed effort initiated by Japan—a member of ASEAN+3—began in 2001 with a proposal to establish more significant rice stocks through an East Asia Emergency Rice Reserve (re-established as the ASEAN Plus Three Emergency Rice Reserve Program in 2010).[46] Starting in 2004 and ending in 2010, a pilot program was established to assess the feasibility of establishing a more permanent reserve system among the ASEAN+3 countries. The new reserve scheme differs from previous ones in several ways. First, rice distribution under the East Asia reserve system would be geared more towards structural deficiencies and increasing investments into the agricultural sector as a whole, rather than merely as a stopgap for national emergencies or calamities. The rice distributed under the reserve would also serve as a price stabilizer in the region. Second, the price, terms, and conditions of the rice distributed from the reserve would be established at the regional level, not bilaterally as the old scheme mandates. So far, the pilot program has provided disaster assistance and malnutrition programs in Cambodia, Indonesia, and Myanmar.[47] Finally, rice stocks would increase substantially to a total of 787,000 metric tons, with 250,000 tons coming from Japan, 300,000 from China, 150,000 from South Korea, and the remaining 87,000 from ASEAN countries. Discussions to make the new reserve scheme permanent are currently underway, with members of the ASEAN+3 meeting in October 2010 to finalize an agreement.[48]

South Asian Association for Regional Cooperation

Established in 1985 and composed of eight countries, the South Asian Association for Regional Cooperation (SAARC) has not produced many practical outcomes under its mandate to enhance regional coordination in trade and development. Critics have noted that the organization's ineffectiveness is largely the result of the historical rivalry between India and Pakistan, SAARC's largest and most influential members. The latest summit held in April 2010 was no different, although SAARC did issue a declaration expressing collective concern over the projected impacts of climate change in the region.[49]

SAARC's effort to address food insecurity in the South Asia region is enshrined in the 2008 Agricultural Vision 2020 and the Regional Strategy and Programme for Food Security. With the majority of South Asia's population living in rural areas (ranging between 66% of the population in Pakistan and 86% in Nepal), both policy pronouncements recognize the importance of agricultural and rural development in reducing poverty and hunger in the region. The Strategy contains the most concrete set of initiatives to date, with SAARC members agreeing to implement 10 projects in the region to address issues such as farmer productivity, protection of natural resources, technological innovation, biosecurity and food safety, and agricultural trade.[50] Cereal and pulses are the main food crops targeted

[46] Formally established in 1999, ASEAN+3 includes the East Asian countries of China, Japan, and South Korea.
[47] Jet Hermida, "Emergency or Expediency? A Study of Emergency Rice Reserve Schemes in Asia," http://asiadhrra.org/wordpress/2007/12/16/emergency-or-expediency-a-study-of-emergency-rice-reserve-schemes-in-asia.
[48] Siti Rahil, "Japan, East Asian Nations Closer to Pact on Emergency Rice Reserve," *The Japan Times*, May 8, 2010.
[49] See, for example, Ben Arnoldy, "India, Pakistan PMs Highlight Ancestral Ties at SAARC Meeting," *Christian Science Monitor*, April 29, 2010.

in the documents, and both documents set out a broad array of principles for member countries to follow to enhance agricultural development in the region.

Notwithstanding the broad scope of the Vision and Strategy, SAARC has instituted two initiatives that could eventually improve regional coordination to address food insecurity. The first is the SAARC Food Bank, which was established in 1988 and operates along the same line as the ASEAN Food Security Reserve in providing emergency assistance and acting as price stabilizer for food in times of price shocks. The agreement to establish a Food Bank, to be housed in Bangladesh, set a reserve of 243,000 metric tons of both wheat and rice. In 2009 the reserve stock was raised to 489,000 metric tons, largely as a response to the 2007-08 food crisis. However, the Food Bank has not received the necessary contributions from member states to become operational. The second initiative by SAARC is the establishment in 1989 of the SAARC Agricultural Centre. Since its founding, the Agricultural Centre has been a key source of research and knowledge in agricultural development for SAARC member states. The Agricultural Centre produces publications, provides training and workshops, and houses a number of scientific databases for agriculture related research.

Asian Development Bank

The Asian Development Bank (ADB) may be a smaller actor among the larger regional and international organizations, but its role as the leading regional financial lending institution makes it a critically important player in the region. ADB takes a comprehensive approach to food security in Asia. Its loans and grants target the rural and agricultural sectors of countries and include projects on promoting technological advancement, securing the natural resources base, building climate change resilience, enhancing partnerships and coordination with other actors (e.g., the private sector), and strengthening systems of governance. ADB's Operational Plan for Sustainable Food Security in Asia and the Pacific sets out a comprehensive strategy guiding ADB's efforts to promote the realization of Goal 1 of the MDGs. It uses all ADB's core and other areas of operations (i.e., infrastructure, environment, regional cooperation, finance, education, health, and agriculture) to address food security challenges, not just agriculture alone.

Since the 2007-08 food crisis, ADB has committed to doubling its financing for food security projects in Asia to $2 billion annually from 2010-12. The Operational Plan provides a "multisectoral" plan that targets three "binding constraints" to food security. These constraints include:

- Declining agricultural productivity, primarily as a result of a decline in the quality and quantity of available water and land;
- Lack of access to markets, technology, finance, and infrastructure by poor rural and urban households and vulnerable populations (e.g., women); and

[50] To read the Regional Strategy and Programme for Food Security see http://www.saarc-sec.org/areaofcooperation/cat-detail.php?cat_id=44.

- Climate change and its projected impacts on both productivity and natural resources.[51]

The conceptual approach used by ADB to mobilize resources for sustainable food security builds on these binding constraints and their removal through programs in five core and "other" areas of operation.[52] ADB emphasizes improvements in agricultural productivity, connectivity within inclusive food and agricultural value chains, and improved resilience at the level of farm and consumer households. This general approach—improving productivity, connectivity, and resilience—is also used in this Task Force report.

It should be emphasized that the Task Force does not propose the creation of new regional institutions to cope with the problems analyzed in this report. As outlined above, Asia already has an effective set of organizations and institutions with clear mandates to engage in food security issues. These entities and programs all have the potential to build on and implement the recommendations in this report, and to provide effective analysis of and coordinate responses to regional food security challenges.

[51] ADB, *Operational Plan for Sustainable Food Security in Asia and the Pacific* (Manila: ADB, 2009).
[52] ADB's areas of operation include infrastructure, environment, regional cooperation, finance, education, health, agriculture, and disaster and emergency assistance.

The Scientific Opportunities in Rice—Public and Private

Policy makers are increasingly recognizing that greater agricultural research investment is essential to increasing agricultural production to meet the needs of a growing population and to address emerging challenges such as adaption to climate change, increasing weather variability, water scarcity, and increased price volatility in global markets. All these general issues apply to rice research. But public investment in rice research in developing countries has not kept pace with the growing demand for this food crop since the early 1990s, and private sector investment in agricultural research in the developing world is just beginning to be a factor. Mainly as a result of re-emerging food security concerns, not only investments at national and international levels but also emerging public-private partnerships have reaccelerated and are slowly approaching levels needed to sustain rice food security. This section outlines the scientific opportunities in rice research that need to be funded to reach that goal. Later sections broaden the discussion to include other agricultural products and the rural non-farm economy.

Rice Research in Asia: The Public Sector

Asia has the world's largest concentration of rice research, which is conducted at government and higher-education agencies, nonprofit institutions, non-government organizations, international agricultural research centers (specifically IRRI), and private for-profit companies. In many Asian countries, a significant part of the national rice research is conducted by specialized rice research institutes such as the Philippine Rice Research Institute or the Chinese National Rice Research Institute. Typically, these specialized institutes belong to larger bodies that have a national responsibility for agricultural research, such as the Chinese Academy of Agricultural Sciences and the Indian Council on Agricultural Research. The Indian Council on Agricultural Research has two large multidisciplinary institutions to conduct research on rice: the Directorate of Rice Research for irrigated rice ecologies, and the Central Rice Research Institute for rainfed environments in India. A good deal of rice research is also being done in various other organizations of the Council responsible for resource and multicommodity research.

In addition to these formal rice research institutes, universities and other government or nonprofit agencies are also engaged in rice research. The university sector is particularly strong in countries such as India, China, and Japan, but differences exist in the nature of rice research in this sector. In many countries, universities focus more on basic research and have their own projects and partnerships. In India, however, State Agricultural Universities have been modeled around the U.S. Land Grant University model, with teaching, research, and extension as three integral pillars. Hence, these Indian universities participate actively in upstream and downstream research, and also have statewide responsibilities for frontline

extension activities such as farm testing and transfer of new technologies. Universities in China also play a strong and increasing role in applied research for extension purposes. Similar developments can be found in some other countries such as Nepal, Pakistan, and the Philippines.

Coordination of national rice research and extension activities across the government and university sectors is often faced with difficulties. Whereas government institutes tend to operate on the basis of medium-term and annual plans (and budgets), the more diverse university sector lacks such a central R&D planning and management approach. Duplication of research is not uncommon, and potential synergies that could result from better cooperation are often not harnessed. The Indian system is an exception in that it has a mechanism to coordinate research by various public organizations, and this responsibility is supported by the Indian Council on Agricultural Research and managed by the Directorate of Rice Research.

Exact figures of recent investments in rice research and development in Asia are difficult to obtain, especially because of rapid changes during the past few years. The most recent comprehensive data from the early 2000s indicate funding that is less than congruent with the production value or food security importance of rice. However, in light of the re-emerging food security concerns in Asia, many governments have significantly increased their investments in the agricultural sector in recent years, including rice and rice research and development. India, for example, has heavily invested in the National Agricultural Innovation Project; extension efforts are accelerated through the National Food Security Mission, and the Indian Council on Agricultural Research is currently recruiting many new scientists. China has recently announced massive investments in the agricultural biotechnology sector. Countries such as Indonesia and the Philippines have set ambitious targets for raising rice productivity at annual rates of 3% or more during the coming years. In 2005, Thailand created a new Rice Department under the Ministry of Agriculture and Cooperatives. The Rice Department deals with all aspects of the Thai rice sector, including R&D.

Although some non-government organizations play a significant role in rice research, their overall proportion of the total research and development output remains quite small. Well-known examples include the Energy Research Institute and the M.S. Swaminathan Research Foundation in India. More partnerships between civil society organizations and the research sector have been emerging in recent years. The increasing role of international organizations and international agricultural research centers in the region is also facilitating such partnerships, through national projects or regional networks and consortia.

IRRI continues to make major contributions to global rice research. Despite stronger national rice research agencies in countries such as India and China, IRRI continues to play a leading role in Asia. But IRRI suffered from a major decline in funding from the early 1990s onwards; the decline in unrestricted funding was particularly large (from 70% of total funding in 1990 to 21% in 2009). Because unrestricted funding is needed to fund long-term programs, staffing, and infrastructure, IRRI had to curtail many of its long-term research and capacity building programs, particularly in rice breeding. IRRI's total staff

was reduced from a high of nearly 3,000 in the late 1980s to less than 1,000 by 2007.

In recent years, however, IRRI's annual budget has nearly doubled, from close to $30 million in 2006 to about $54 million in 2009, as a result of three major factors. First, IRRI's new strategic plan for 2007-2015 represented a significant change from previous priorities. More emphasis is now placed on marginal rainfed environments, diversification of rice systems, the sustainability and environmental consequences of intensive rice production, and genetic discovery research. New programs were started on improving human health through biofortified rice, and rice in Eastern and Southern Africa.

Second, in response to the re-emerging concern about global food security, also in light of climate change, and the global rice price crisis in 2008, an action plan was developed on how rice research and development should be accelerated for greater and faster impact. Finally, the increased focus on a more product-oriented research and development approach resulted in stronger donor support, particularly by new donors. IRRI still receives most of its funding from traditional CGIAR donors, but the Bill and Melinda Gates Foundation has become a major new donor for international rice research in Sub-Saharan Africa and South Asia over the past 3 years. In 2009, the Foundation accounted for about one-third of the annual budgets of IRRI and AfricaRice. Many of these grants initially focus on short- to medium-term impacts (products already in the pipeline), but also provide support for basic research. If secure funding can be arranged, a number of research opportunities would open to rice researchers in the region.

Rice Research in Asia: The Private Sector[53]

Breeding of improved rice varieties worldwide has been dominated by the public sector, while the private sector has mostly focused on developing pesticides, fertilizers, and machinery for rice cultivation. As public-private partnerships improve in rice research, the availability of data on the absolute or relative size of the investments of the private sector in rice research and development should be increased. The limited role of private research and development in rice breeding has been primarily due to the fact that companies could not easily appropriate part of the gains in yield and quality that farmers obtain from improved varieties. Rice is a naturally self-pollinated plant, and so it is easy for farmers or seed companies to reproduce any new variety. In recent years the ability of private firms to appropriate gains from rice research and development has increased, which has induced companies to start investing in rice breeding. In addition to advances in hybrid rice, another important development is the ability to develop and patent biotechnology innovations. Both of these developments are controversial because so much of the basic knowledge of plant science and genetics used by private firms originated in public sector laboratories. Further, the safety of genetically modified organisms (GMOs) remains a source of contention, although Task Force members believe that the tools of modern biotechnology will be needed to resolve long-run issues of agricultural productivity and sustainability.

[53] This section focuses on the private for-profit sector. Nonprofit private agencies such as cooperatives and producer organizations are discussed under public agricultural research and development.

Hybrid Rice

The first rice hybrids were released to Chinese farmers in 1974, and with substantial government support they were quickly spread among farmers and today cover more than 17 million hectares, about 60% of China's rice cultivation area. Research on rice in China continues to be dominated by public sector research institutes. The Seed Law, which was passed in 2000, officially allowed private Chinese firms to produce and sell seed. Foreign firms are restricted to a minority stake in a seed venture and are prohibited from participating in rice seed production and sales. Private firms are just beginning to add rice breeding programs to their activities. Two of the largest private rice breeding programs in China are Yuan Longping High-Tech Agriculture Company and Da Bei Nong. Both were started in 1999 in anticipation of the new seed law and have recently released their first proprietary products.

Estimates of the global diffusion of hybrid rice remain somewhat uncertain, but it appears that hybrid rice is now grown on about 20 million hectares (or about 13%) of the world's rice land. The major research and development investments made by the private sector in recent years will likely lead to significant technological progress and a more rapid increase in hybrid rice area outside of China. A key consequence of these developments is that the public sector research and development system needs to redefine its role in hybrid rice development, focusing on public-private partnerships in which the public sector acts more as a pre-breeding and general research provider rather than trying to commercialize hybrids themselves.

Indeed, the public sector has been the backbone of private efforts to date. IRRI has been a major source of restorer lines for the Chinese hybrid rice programs and revived its own hybrid rice breeding program in 1979. Through the efforts of IRRI, public research institutes in India, Vietnam, Indonesia, and the Philippines established their own hybrid rice programs in the 1990s, which led to the release of a first generation of public sector hybrids (mostly from IRRI or with IRRI parents). In addition, there are also the first cases in which private companies have licensed rice hybrids bred by the Southeast Asian public research and development sector. DuPont, for example, has recently licensed hybrids and breeding lines from the Indonesian Centre for Rice Research.

Biotechnology

A second factor leading to increased private sector interest in rice breeding is the ability to develop and patent biotechnology inventions. In the 1990s, Monsanto and Syngenta invested substantial amounts of money in mapping the rice genome, which was partially contracted out to universities and built on research networks financed by the Rockefeller Foundation and the Japanese government. The private sector's main interest in the rice genome was its potential application to other crops such as maize.

The potential for future earnings from transgenic traits in rice has attracted most of the major agricultural seed-biotechnology firms to invest in rice biotechnology research both in-house and through collaboration with public institutes. DuPont/Pioneer, Bayer, Syngenta,

and BASF have in-house basic biotechnology programs that include rice, and have located biotechnology research facilities in the United States, Europe, India, Singapore, and China. Some of these companies have partnerships with small biotechnology firms to develop yield traits for rice. These companies also engage in collaborative biotechnology rice research with IRRI and with the public sector in many countries, most extensively in China.

Future roles of public and private sector R&D investments in biotechnology depend largely on access to advanced technologies, proprietary information, regulatory costs for transgenic events, and the ability to implement excellent product stewardship. In some cases, public sector institutions will be able to utilize proprietary biotechnology developed in the private sector, for example through free licensing mechanisms that restrict usage for nonprofit purposes to certain world regions (developing countries). Golden Rice, enriched with Provitamin A, is one example for this model, where the public sector has been granted a license for such humanitarian purposes. However, any decision to undertake research activities leading to the development of a transgenic rice product entails a considerable financial commitment over a long period of time, due to lengthy and uncertain regulatory procedures for approval. Improving the regulatory environment is essential to ensuring that the development and commercialization of transgenic traits will not remain in the hands of just a few companies.

Opportunities to Strengthen and Upgrade the Rice Breeding and Research Pipelines

Funding for the development of new rice varieties has steadily declined over the past decade or more. This decline must be reversed in order to develop the new rice varieties that will be required for sustained productivity growth. Opportunities exist to accelerate the development of new rice varieties with increased tolerance of abiotic stresses (such as drought, flooding, and salinity), resistance to insects and diseases, and improved micronutrient content through new precision breeding approaches. Likewise, revitalization of research on rice crop and resource management is needed.

From identifying desirable rice traits to the wide adoption of varieties incorporating them is a long and exacting process spanning up to 15 years. The need for a large and comprehensive global program to develop new varieties for rice production environments and bring new seeds to farmers faster is becoming more compelling, and it will require engagement of a wide range of public and private sector organizations and networks. New approaches can shorten varietal development cycles by 3 to 5 years and allow breeders to design new varieties and improve existing rice varieties and hybrids more precisely.

These new approaches must be implemented through well-designed, product-oriented, interdisciplinary and interconnected breeding programs in the world's major rice regions. For example, great opportunities exist now to further develop and spread new rice varieties from inter- and intraspecific crosses. A quantum increase in yield can be made in rainfed systems by creating new varieties that tolerate abiotic stresses such as drought, iron toxicity, submergence, salinity, and heat.

Demand is increasing from consumers for better quality rice varieties. Also, rice must become more resilient to climate change. For this, better information on the spatial and temporal variability of the environments where rice is grown must be gathered, as well as information on the preferences of farmers, processors, and consumers; new cultivation practices used by farmers; and the impact of climate change. This information can then be used to guide rice breeding programs in a precise manner. Interdisciplinary breeding teams, integrated across mainly public sector partners who share critical facilities and learn from each other, can then identify and define ideal rice phenotypes (ideotypes) for different production environments and those that are adapted to future cropping systems, as well as key biophysical and socioeconomic constraints and market demand. They will also enable better South-South transfer of genetic information for a particular breed of rice, making innovations from leading national agricultural research and extension systems available to other countries, and create better linkages with the private sector. The tools for parental selection and better understanding of the genetics of agronomic traits should lead to more efficient breeding programs that make optimum use of the available resources.

Bofortification, promoted by HarvestPlus, advances breeding nutritionally enhanced rice varieties, among other staple grains, to improve the nutritional status of vulnerable populations who are too poor to consume a diversified diet. Such breeding for higher trace mineral density in seeds need not incur a yield penalty, and mineral-packed seeds are attractive to farmers because these trace minerals are essential in helping plants resist disease and other environmental stresses. Additionally, more seedlings survive and initial growth is more rapid. Ultimately, yields are higher, particularly in arid regions where trace mineral deficient soils exist.[54]

Micronutrients for rice breeding have targeted iron and zinc, given the positive correlation between the two minerals in rice varietals. Zinc-enriched rice is in late stage trials in Bangladesh, slated for release in 2013. Human trials of iron-enhanced rice revealed increased iron intake in a community of nuns in the Philippines without any other dietary changes.[55] Importantly, these advances in rice biofortification are not dependent on the introduction of micronutrients from other plants, such as golden rice, but exploit the natural variation in zinc and iron content across different rice varietals, and thus do not face the controversy surrounding transgenic crops.

Opportunities to Accelerate Research on the World's Thousands of Rice Varieties

Thousands of rice varieties exist throughout the world, and research on these varieties must be accelerated. This research will enable scientists to tap the vast reservoir of knowledge that rice varieties contain. Working with IRRI, the nations of Asia have spent decades carefully

[54] Howarth E. Bouis, "Micronutrient Fortification of Plants Through Plant Breeding: Can It Improve Nutrition in Man at Low Cost?" *Proceedings of the Nutrition Society*, 62 (2003): 403-11.

[55] Jere Haas, John Beard, Laura Murray-Kolb, Angelita del Mundo, Angelina Felix, and Glenn Gregorio, "Iron-Biofortified Rice Improves the Iron Stores of Nonanemic Filipino Women," *The Journal of Nutrition*, 135 (2005): 2823-30.

collecting the region's thousands of rice varieties. More than 100,000 types of rice are now being carefully managed and used at IRRI and in Asian nations. However, scientists have studied in detail only about 10% of these types. It is urgent that researchers learn more about the other 90% so these can also be used in the development of new varieties.

Genetic diversity is the foundation for the genetic improvement of crops. Knowledge of multiple facets of rice genetic diversity from the molecular to the phenotypic (observable characteristics) is essential for effective conservation and use to meet both current and future needs. Although the genetic makeup of rice and a vast catalogue of genes have been revealed as a result of recent advances in biotechnology, most of their functions remain largely unknown. Thousands of undiscovered genes can potentially benefit rice productivity and quality. The processes to decipher their functions are complex, requiring cutting-edge biotechnology, phenotyping methods, and bioinformatics. An individual institution can cope with only a few of these processes at a time. If we are to exploit the rice genome adequately in a timely manner to help increase the world's rice harvests and nutritional content, a global research effort is needed, integrating the strengths of public and private organizations and facilities, from high-tech laboratories to farmers' fields. The CGIAR, through existing centers and new research networks as a basis for wider partnerships, is ideally placed to lead this effort.

The research further draws together germplasm (collection of genetic resources) conservation, diversity analysis, gene discovery, and dissemination of advanced genetic/breeding resources, presenting a unique opportunity to maximize the use of conserved and customized germplasm. Because water is fundamental to rice productivity, traits dealing with stress related to water—too little or too much—should be the core concern of this global effort to reduce risks to farmers and to mitigate the effects of a changing climate. Research should also include a wide spectrum of genes for other traits that have high impact in the various rice production environments. Where these traits can be exploited by using higher micronutrient varietals this represents a win-win scenario, producing submergent, salt, or drought tolerant varieties that are both high yielding and rich in micronutrient content.

The basic approach is to improve the conservation, characterization, and use of the world's rice gene pool for varietal development by joining the resources of organizations across the globe. This will mean joint management of the world's rice genetic resources, both in gene banks and in research, development, and extension institutions. The research should capitalize on the rapid advances in DNA sequencing technologies to reveal rice diversity in a comprehensive manner. We can learn from plant species with better photosynthetic efficiency and nitrogen-fixing capability how to redesign the rice plant for greater productivity for the future.

Finally, the research will provide the foundation for new international rice breeding programs, leading to new and improved rice varieties and cropping systems. These programs will also improve both *in situ* and *ex situ* conservation of the world's rice genetic resources. Broadened access to genetic resources and tools by breeders, researchers, and

plant biologists is expected to improve the efficiency of rice breeding and gene discovery activities among partners, enable precision breeding, and accelerate the achievement of breeding programs. The research products will all be international public goods to be used by the global rice research and breeding communities. This outcome requires an open environment for germplasm exchange and sharing.

Developing a New Generation of Rice Scientists and Researchers

Another vital concern for the Asian rice industry is the education and training of young scientists and researchers from rice-producing countries. If the region's rice industry is to successfully capitalize on advances in modern science, Asia urgently needs to train a new generation of rice scientists and researchers (including social scientists) before the present generation retires. Universities, national rice and education policy makers, the private sector, and advanced research institutions must begin building a new cadre of rice scientists. Doing so will require a comprehensive package of educational initiatives and incentives to attract a next generation into this field, with great scope for South-South partnerships. This package should include:

- **Advanced Education.** Advanced degree programs and vocational training in rice research should be developed as part of Asian national agricultural research systems. Research capacity should also be built in specific areas for individual scientists through a range of short-term courses and capacity building through research partnerships and internships, including in the private sector.
- **Scholarships.** Universities across the world should finance scholarship programs to support the development of rice research capacity at both the doctoral and advanced graduate level. Scholars should be able to design, conduct, and report on research that addresses farmer needs within national priorities and within a global context. IRRI, for example, has proposed establishing a Global Rice Science Scholarship.
- **Attracting New Talent.** The future of rice research will depend on a continual influx of high quality people into this career field. In addition to providing scholarship opportunities for advanced education in rice research, establishing learning labs in rice science for young people and pre-university students will help expose a next generation of scientists to the excitement of rice science. More public-private partnerships, for instance, would help facilitate this.[56]
- **Educating Policy Makers about Food Security.** The above initiatives focus primarily on rice scientists, including social scientists, but there is also a clear need to develop a substantial cohort of policy makers in Asia who are fully cognizant of the technical, economic, and political dimensions of food security in the region.

[56] See, for example, the John Deere Foundation's scholarship support and faculty development efforts. Accessed at http://www.deere.com/en_US/globalcitizenship/socialinvestment/education/index.html.

Several initiatives in this area are underway: Renmin University in Beijing has started a new academic department and research center that focuses on food safety and security from an economics perspective, and the Crawford School of Economics and Government at Australian National University has proposed a new academic track—including executive training, masters programs, and a Ph.D. in food policy and food security—that would be carried out jointly with other universities in the region.

On-Farm Efficiency

About three-quarters of the world's rice supplies are obtained from irrigated lowlands, which have been demonstrated to be extremely sustainable during three millennia of continuous production in Asia. This sustainability is now threatened, however, by rapid population growth that has resulted in a declining share of land, water, and energy resources going to rice production. Labor shortages are growing because of rural-urban migration, and the burden of agriculture falls increasingly on the shoulders of women and older men who remain behind. Other threats to sustainability arise from inefficient use of production inputs (e.g., fertilizers), which leads to pollution, environmental degradation, and declining ecosystem services. In some areas, the ecological resilience of rice ecosystems and their capacity for natural pest control are weakened by the overuse of pesticides and breakdown of rice host-plant resistance. It is estimated that pests (nematodes, insects, rodents, and birds), diseases, and weeds are responsible for a 25% to 45% loss of rice production in tropical and subtropical Asia. Market-driven diversification, while offering potential for increasing farm income, also presents new challenges for sustainable management. Overarching these issues are the threats of—and possible opportunities from—climate change.

An Agronomic Revolution in Asian Rice

Depending on production conditions, an unexploited yield gap of 1-3 tons per hectare currently exists in most farmers' fields in rice-growing areas of Asia. Such yield gaps can be reduced through the use of better crop management practices, particularly in irrigated environments. This requires funding support for programs aimed at improving farmers' skills in such practices as land preparation, water and nutrient management, and control of pests and diseases.

Significant increases in rice productivity globally are possible through improved agronomic practices that aim at exploiting these persistent yield gaps. Such an agronomic revolution—perhaps one of the most powerful short- to medium-term interventions—must focus on the integration of better adapted germplasm and improved field and landscape management practices. This requires good understanding of these yield gaps, and interdisciplinary approaches that aim at designing sustainable, highly efficient, and ecologically resilient rice-based cropping systems. Much can be learned in this arena by sharing experiences across different world regions—a major opportunity for South-South cooperation. One controversial area where global knowledge sharing might pay high dividends is the System of Rice Intensification (SRI), a largely organic system of rice cultivation that seems to produce sustainably high yields in some circumstances.[57]

In Asia, Africa, and Latin America rice is also cultivated in upland ecosystems (about

[57] For more information on the System of Rice Intensification, see http://info.worldbank.org/etools/docs/library/245848/index.html.

40% of the rice-growing areas in Sub-Saharan Africa and in Latin America). Given the fragility of this environment and the poverty of the smallholders in this ecosystem, innovative low input cropping management based on conservation agriculture, diversification of farming systems, and improved value chains will be needed to improve livelihoods of the poor.

High-Yielding Rice and Other Crops

New varieties exist that could increase production of rice and other key staples, but farmers are not using them, mainly because the systems that develop and introduce new varieties are under-resourced. Research to solve this problem should focus on developing new crop, resource, and pest and disease management options in response to major drivers of change that will shape the future of rice production: increased market linkages and options for diversification; climate change; and land, water, energy, and labor scarcity. Strategic and process-based research should be conducted in greenhouses and experimental fields to derive generic scientific principles that will underpin the development of improved crop and natural resource management options.

Location-specific management options should be developed through on-farm adaptive and participatory research. In areas that specifically suffer from drought, submergence, iron toxicity, or salinity, management technologies to accompany the introduction of newly developed stress-tolerant rice varieties will be introduced simultaneously. In intensive rice production systems, research will focus on opportunities for, and challenges to, ecological intensification and crop diversification (e.g., rice, wheat, maize, pulses, potato).

In order to accelerate the introduction and adoption of higher yielding rice and other crop varieties, the following products must be created:

- Innovative technologies for ecological intensification of rice production systems under current and future climates;
- Methods to enhance ecological resilience for pest and disease control under current and future climates in Asia, Africa, and Latin America;
- Management innovations to cope with abiotic stresses under current and future climates;
- Integrated cropping system innovations for future intensive rice systems in Asia;
- Better seed systems that include harmonization of seed policies in the region, joint variety testing, and rapid approval, multiplication and dissemination of new seeds;
- Farm management innovations for lowland rice-based systems in Africa across an intensification gradient;
- Farm management innovations for upland rice-based systems; and
- Better understanding of the potential of rice-fish cultivation systems to improve dietary diversification, including whether there are any long-run yield trade-offs for rice production.

Postharvest Technology for Rice

Postharvest operations include the storing, drying, and processing of rice. Most farmers in Asia suffer considerable losses in terms of both quantity and quality of rice during postharvest operations, largely due to poor harvesting organization and limited access to modern equipment. New technologies for on-farm storage and drying can reduce losses considerably and pave the way to add further value during processing and delivery to the retail customer. Novel ways must be developed to add economic and environmental value to rice crops through a reduction in postharvest losses; improved access and supply of quality grain and rice products to current markets and emerging specialty markets, improved value chain linkages and efficiencies; and innovative uses of husks and straw to produce biofuels, cut carbon emissions, and increase carbon sequestration.

Present postharvest processing in the developing world causes physical and quality losses of as much as 20% to 30% in some circumstances. One reason for the slow progress in improving the postharvest value of rice is the separation of the three segments of the sector: production, processing, and marketing. Farmers would benefit from better information flows and linkages with processors and retailers on general and emerging market trends, and from opportunities that could influence their choice of rice varieties, as well as better understanding of causes of and solutions for postharvest losses.

Furthermore, about 550 million tons of rice straw and about 110 million tons of husks are produced in Asia each year. Disposal of these by burning, for example, causes emission of greenhouse gases. Innovative uses—such as bioenergy and biochar—of husks and straw will provide local business opportunities and extra income sources for farmers, and simultaneously mitigate, instead of accelerate, climate change. Another mitigating option is improving the digestibility of straw so it can be used as livestock feed.

There is increasing global awareness of the complex nutritional dimensions of food and the environmental impact of producing it. For example, identifying low glycemic rice will assist Type II diabetes sufferers. Unpolished or partially polished rice is currently vacuum-packed to prevent rancidity. Eliminating the biological causes of rancidity will increase consumer access by decreasing packaging costs. Faster-cooking rice will greatly minimize the carbon emissions from cooking rice. Other opportunities to add value are rice products, such as high-value oil from the bran, and high-energy biscuits for malnourished children. Supplying rice varieties to these high-value markets will increase economic benefits to farmers and nutritional benefits to consumers worldwide.

Micronutrient fortification of grains has usually been restricted to wheat and maize flours because it is easy to blend in the fortificants. That has never been possible with rice as it is consumed as a whole grain—any added fortificant would just be washed off during preparation. However, there are now techniques to grind rice into flour, fortify it, and then reconstitute it into rice grains so it is eaten as normal. The cost to fortify rice in this way pushes up the price of rice by about 2%-4%, which is about 10 times the marginal cost of fortifying wheat. This technology is currently restricted mostly to developed countries.

But the potential for rice fortification in developing countries is far greater, as a larger range of micronutrients can be added and at higher levels without producing changes in color and taste. Rice productivity increases that drive down the price of rice could have as a side benefit the potential to reduce the cost of fortified rice below the current unfortified price.

Improving Farmer Access to Markets

Farmers face high costs and multiple risks as they try to access input and output markets, but engagement with these markets is the only way to provide farmers with new technologies, productive inputs, and profitable outlets for their production surpluses. Efficient infrastructure, including the information systems that allow farmers to participate in market transactions with full knowledge of prices, input quality and characteristics, and the risks involved, is the key to giving farmers access to markets. Farmer organizations, as part of a broader community of civil society organizations, as well as more public-private partnerships, can also lower the transaction costs of providing farmers with effective access to input and output markets. Greater institutionalization of linkages from research to extension to farmers and to markets could benefit millions of farmers.

Investing in Agricultural Infrastructure and Information Systems

Efforts to build efficient, transparent, and accessible food marketing systems are at the very core of agricultural development and a successful structural transformation. It is no surprise, then, that most societies have actively pursued these efforts as a matter of public policy, usually at the national level. At this level, a country's domestic economy interfaces with the global economy, and the opportunities for profitable international trade naturally stimulate attention to the marketing system that conveys this trade in both directions. Indeed, much of the development profession has focused on the powerful impact that international trade has on productivity growth and speed of economic development.

Efforts to develop domestic marketing systems in rural areas have received much less attention, although the most successful Asian economies have actively fostered efficient links between small farms growing staple foods (especially rice) and their expanding urban consumption centers. These links were seen as a critical component of a country's food security, as the world rice market was considered much too thin and unstable for large countries to rely on as a major source of their primary staple food. Hence there is considerable Asian experience on how to develop efficient rural markets, but mostly from the perspective of rice marketing, and mostly from the objective of moving rice from farms to urban consumers. There has been less attention to developing rural marketing systems in general and value-adding supply chains in particular, with most of these non-rice investments left to the private sector. Still, these investments have been forthcoming in the right economic and political environment, and there is much to learn from the success stories that have been documented. One key lesson is that adequate investments in agricultural infrastructure such as roads, irrigation systems, and market systems are critically important for raising and sustaining productivity growth in rice and other foods, and for generating dynamic non-farm rural economies

that are a primary route out of poverty.[58]

A comprehensive rice information gateway should be developed that synthesizes and makes available rice knowledge worldwide and provides accurate science-based information to policy makers, donors, scientists, agricultural professionals, farmers, and the general public. Data should be collected and analyzed—disaggregated by gender—on household and farm characteristics, the resource base of households, labor use, income levels, farmers' perceptions on technology needs, technology adoption patterns and constraints, and farm-level effects of technologies on representative households.

The information gateway should also include general information on all aspects of rice production; policies; statistics; studies and projects; global market information, such as on seed, fertilizer, and equipment; best management practices; and even prominent persons in the sector. The data should feed into new predictive tools to identify what research opportunities offer the greatest expected benefits to the poor and the environment. On-the-ground economic, environmental, and social impacts of technology adoption should be assessed when research products are near their peak level of adoption, while more immediate feedback to scientists should be provided through qualitative evaluation approaches focused on early adoption. Again, the scope here for South-South partnerships is large.

Reforming the Policy Environment for Markets

Governments must be at the forefront of any concerted effort to improve the rice sector in their country. The role of government should optimally be to create the enabling environment and resources for the many public and private stakeholders to carry out the required research, development, and extension of rice. But in many rice-producing countries, the fragmented nature of the rice sector—production, processing, and marketing systems—has resulted in a lack of effective policies to improve the functioning of the sector and make it more equitable. Rice is, in general, a highly regulated crop and very much affected by policies related to inputs and outputs. These policies often impede an effective role for the private sector in raising productivity on farms, investing in job creation off the farm, and building a market economy that can reduce poverty.

Often, inappropriate policies and measures to implement them are due to the lack of good quality information at high spatial and temporal resolution on farmers' technology needs, rice ecosystems, yields, input use, rice markets, and prices. Accurate information on the global rice situation can have a strong impact on rice market prices and influence policies. Indeed, better and easily available information can help to fine-tune national and regional rice development strategies and guide priority setting for public and private sector investments. Further, it can lead to harmonization of policies at the regional level, especially through a formal system of information sharing among countries and regional groupings

[58] ASEAN Secretariat, World Bank, Asian Development Bank, and Food and Agriculture Organization, *Trusting Trade and the Private Sector: Policy Reforms, Private Investment in Food Supply Chains and Cross-Border Trade Facilitation* (forthcoming 2010). Also see World Bank, *Agriculture for Development: World Development Report 2008* (Washington, DC: World Bank, 2008), for a discussion of infrastructure needs for agricultural development.

such as ASEAN, SAARC, and the Pacific Islands Forum.

Policy makers, donors, research managers, industry leaders, and others also need to come together to identify more accurate evidence-based information on specific constraints and research needs and the impact of rice research and development investments to date, in order to generate political support and target continued investment in rice research. Additionally, in the absence of market feedback, publicly funded rice research requires systematic analysis of expected impacts, so as to target future investments and establish metrics for monitoring and evaluation. The goal should be to improve domestic and international marketing systems. Policies can be developed and implemented to remove barriers to the efficient transmission of price signals and to create conditions that allow the private sector to function smoothly.

Building Capacity of Smallholder Farmers to Access Markets

Farmers with only small surpluses to sell, or who purchase small quantities of inputs, often face high costs in accessing markets. Linking to global efforts to promote smallholders' agricultural production and access to markets with the aim of addressing food insecurity and poverty, the World Food Programme (WFP) has launched a pilot program called "Purchase for Progress" (P4P). Implemented in 21 countries[59] over a period of 5 years (2009-2013), this market development program seeks to connect smallholder farmers to markets. The project links WFP's demand for staple food commodities with the technical expertise of a wide range of partners, to support smallholder farmers in boosting their agricultural production, increasing yields, improving quality, and selling their surplus in better integrated, dynamic markets to increase their annual farming incomes. Generally, WFP purchases large quantities of food for distribution in developing countries. In 2009, WFP bought a total of 2.6 million metric tons of food at a value of approximately $965 million. Rice purchases accounted for 13% of these purchases (337,540 metric tons), the great majority of which were purchased in Asia.

To date, WFP has purchased around 1,500 metric tons of rice through P4P modalities in Liberia and Sierra Leone. In Asia, WFP will pilot P4P in Afghanistan and Laos. In Afghanistan, P4P will focus on developing food processing and manufacturing capacity of high energy biscuits, while in Laos, where WFP has substantially increased local in-country procurement of rice over the past 3 years (from large scale traders), P4P will focus on buying rice and oil from smallholder farmers. Purchasing from smallholder farmers is challenging, as P4P's experience in Sub-Saharan Africa and Central America is showing. When local produce is uncompetitive relative to imports, as in the case of rice in West Africa, it is difficult to justify local procurement. Furthermore, limited access to credit to finance aggregation and crop purchases from members emerges as an impediment to the ability of farmers' organizations to market their products, and results in side-selling. Lastly, the lack

[59] The 21 P4P pilot countries are Afghanistan, Burkina Faso, Democratic Republic of the Congo, El Salvador, Ethiopia, Ghana, Guatemala, Honduras, Kenya, Laos, Liberia, Malawi, Mali, Mozambique, Nicaragua, Rwanda, Sierra Leone, Sudan, Tanzania, Uganda, and Zambia.

of storage facilities and postharvest handling equipment is another major challenge facing farmers' organizations, leading to high postharvest losses and high potential side-selling. Under P4P, WFP is providing some basic warehouse equipment such as sieves, pallets, moisture meters, weighing scales, and stitching machines; and with partners, WFP conducts training on food quality specifications, warehouse management, and storage techniques.

Another critical area of need relates to agro-meteorological information. A more extensive and accurate system of weather measurement helps develop insurance markets for rice farmers, which are almost entirely absent at the moment. Instituting crop yield insurance is cost intensive and subject to moral hazard and adverse selection. However, when there is an extensive system of accurate, established weather stations, a different form of insurance instruments can be developed. The insurance should be based on rainfall in certain critical periods of time, as opposed to yield, and pay out almost immediately, providing a safety net for farmers before crop failure and preventing farmers from selling their productive assets. This type of insurance market, which the WFP and World Bank have pioneered, also increases access of rural famers to other financial markets, because credit service providers know that the farmer is protected in the event of crop loss due to adverse weather.

Building a Dynamic Rural Economy that Includes the Poor

A dynamic rural economy offers rapid employment creation, with more and better jobs, and is often stimulated by investments from the private sector. This employment is driven by faster economic growth in rural areas, but such growth is possible only if there is a favorable investment climate. With faster growth of local economies and rising employment, rural poverty reduction can be accelerated, and the rural sector can be more than just a social safety net (as it was throughout Asia during the financial crisis in the late 1990s and again in the late 2000s). The pathway out of poverty for most Asians involves a dynamic rural economy and provision of support and opportunities to those most vulnerable.

Connecting Macro to Micro

A coherently designed macro food policy couples a strategy for food security with a strategy for growth that reaches the poor. Establishing this link to food security from the macro side allows a country to capture growth opportunities, some quite subtle, that are otherwise missed. Such a macro food policy has three components, which in turn reinforce the country's food security: rapid economic growth, poverty reduction through growth in rural productivity, and stability of the food system. Agriculture, especially the rice sector, and a dynamic rural economy are the keys to integrating all three components.

This "macro" perspective on the food economy helps integrate a country's food security at the household level with national food markets. In turn, food security at both levels enhances the prospects for rapid economic growth, poverty reduction, and broad-based participation by citizens in higher living standards. The complexity for food policy arises because the achievement of each of these goals depends on the simultaneous pursuit of the other two strategies, which interact through market and behavioral mechanisms. For example, rapid growth in the macro economy must be designed to reach the poor. Otherwise, poverty reduction is delayed. Likewise, more direct interventions to reach the poor, such as a targeted food distribution program, cannot be sustained if many rural households are poor. Similarly, raising poor households above the poverty line does not guarantee their food security if food supplies disappear from markets or prices rise beyond their means.

Very rapid rates of decline in poverty rates were achieved in Indonesia, China, and Vietnam since the 1970s, and earlier in Thailand, Malaysia, and Northeast Asia. During periods of extremely rapid growth in average incomes per capita, income distribution remained stable or even improved somewhat. Despite this long-run stability in income distribution, there is considerable variance in how well the poor connect to economic growth during shorter episodes. This variance tends to be explained by initial conditions—especially land distribution—and by economic growth. At least in most of Asia, agricultural growth, especially driven by higher productivity in the food grain sector, has tended to be

much more pro-poor than growth in the modern industrial or service sectors. Food prices are also influential in explaining changes in income distribution. Sharply rising food prices are bad for the poor (except in those areas where the poor have access to enough land to be surplus producers of grain, as in a number of regions in China). Rice prices have been especially volatile in world markets over the past half-century.

The potential for climate change to make this precarious and volatile environment even more challenging for the poor is quite worrisome. Climate change adaptation measures, as part of social protection and as a way to move people into productive livelihoods, offer an important venue for reaching those who are currently poor as well as those who will be threatened by loss of livelihoods in the future. Given the direct projected impact of climate change on agricultural production in developing countries, there is a clear imperative to invest in enhancing and adapting agricultural production systems to compensate for the negative effects and meet local and global demand for food.

However, it should also be recognized that limiting adaptation to only increasing productivity bears the risk of missing the needs of the most vulnerable people. Many climate change adaptation measures that focus on agricultural productivity enhancement alone are not likely to reach directly the poorest rural households who typically have limited access to land and other resources. For many food insecure people—children, the elderly, and those with poor health—improving access to food through their own production or labor is not a feasible option. There is a significant risk that those with the fewest assets and capacities, who often live in the most marginal and disaster-prone areas and are most exposed to hunger and food insecurity, will benefit little from availability gains. Adaptation to climate change must include broader safety net features as well as research on agricultural productivity measures.

Stabilizing Food Prices

One of the most serious threats to food security in the short run is the volatility of food prices in general and rice prices more specifically. Government efforts to stabilize rice prices are highly controversial in the donor and academic communities, but most Asian governments do it anyway. If successful, price stabilization programs can be an important stimulus to improving market efficiency while also protecting poor farmers and consumers from sudden price changes. Design and implementation of more effective rice reserve policies in Asia, as well as renewed confidence in the international rice market as a source of both exports and imports, are high priorities for individual countries and the regional community. Substantial research is needed to understand how to design and implement policies that can bring about more stable rice prices and greater willingness to utilize the world rice market to lower the costs of rice to consumers, provide profitable outlets for surplus rice producers, and help balance out the growing instability of local rice production that is expected to result from climate change.

Better information will be an important step in moving forward on this agenda. Real-time data on the rice market and instruments to contain rice price volatility can help national policy makers to forecast and mitigate problems in the sector. In particular,

policies with high deadweight losses, such as expensive government procurements or export bans, are often costly and unnecessary and can usually be avoided with little detriment to national food security. Moreover, these responses can come with real harm to the poor; inappropriate rice market responses contributed significantly to the global spike in rice prices in 2008. Research on this agenda can help to avoid this pattern in the future by providing rice traders and government agencies with better data and understanding of how the world rice market operates, with the goal of more appropriate market responses to anticipated changes in production and consumption.

A more open and stable rice market in Asia would be one of several regional public goods whose provision is beyond the capacity of individual countries. Others include basic agricultural research, timely information on production and consumption trends, and responses to climate change (especially its impact on agriculture and the poor in the region). As ADB has pointed out, these systemic problems require systemic solutions at the regional and global level. Proposals on how to provide these solutions are in the final section of this report.

Linking Agricultural Development Strategies to the Rural Poor

"Pro-poor growth" is the only sustainable route out of poverty. In most Asian countries, the rural economy (broadly) and the agricultural sector (specifically) provide the most effective arena for engaging the skills and labor of the poor in productive activities. There are three basic ways to reduce poverty: redistribute productive assets (especially land) to the poor; provide the poor direct income supplements or subsidies; and connect the poor to rapid, sustained economic growth. Over the past century, Asia has tried all three approaches to reducing poverty. The historical record suggests that only economic growth in which the poor participate can lift large numbers of the population out of poverty and keep them and subsequent generations above the poverty line. Creating the technologies, infrastructure, and environment for such growth requires active government policy and effective public-private partnerships.

The main lesson from Asia's economic history is that poverty reduction succeeds only when there is a basic political commitment to an economic growth process that includes the poor. This commitment has three key components (although the subcomponents might fit in several categories):

- **Rapid growth** is necessary for sustained poverty reduction. This requires macroeconomic stability, including stable food prices, a relatively open trade policy for goods and services, and a competitive market economy that generates labor-intensive growth with rising real wages and greater participation in the formal sector. Such an economy is normally led by the private sector.

- **Efficient government investments and policies** are needed to connect the poor to this growth. These include rural infrastructure, especially farm-to-market roads and communications; public health and education facilities that are accessible

to the poor; technologies that have substantial public good dimensions to them, especially for agriculture and health; and a smooth interface between rural and urban economies, including easy opportunities for rural to urban migration.

- **Effective public-private partnerships** provide the institutional dynamic for pro-poor growth. These require integrating macro (market-level) with micro (household-level) food security; rural-urban financial intermediation for market integration; and local leadership to improve the rural investment climate.

Asia's dramatic poverty reduction in the past was driven by pro-poor economic growth. This growth was made possible by a successful Green Revolution, led by high-yielding rice varieties (and wheat in South Asia and North China), massive investments in rural infrastructure, including irrigation, and the ready availability of fertilizer. The resulting economic growth was the most pro-poor in history and led to the most rapid and widespread reduction in income poverty over four decades that has ever been witnessed.

The close historical connection seen in much of East and Southeast Asia between improvements in food security and reduction of poverty has been a result of government efforts to link market-led economic growth to interventions that improve food security at both the household and national levels. This strategic connection is not an accident and was driven to a large extent by the special nature of smallholder agriculture in Asia, and especially by particular characteristics of Asian rice economies.

Strengthening the Rural Non-Farm Economy

The rural non-farm economy is often seen as a critical component of a broader economic development strategy that links rising productivity in agriculture to rapidly expanding employment in modern industrial and service sectors, usually in urban areas. The steps needed to build a dynamic rural economy are not well understood and vary from region to region and over time. Historically, three broad factors have been associated with rural non-farm economies that played a positive role in the transition from agriculturally based growth to industrial and service based growth. Each of these three factors has, in turn, three components:

Rising productivity in both land and labor in Asia's agricultural sector, which requires:

- *Higher rice productivity through better seed technologies, improved irrigation structures, and farm management.* As noted above, opportunities to raise productivity exist through precision management of inputs, consolidation of rice farming operations through land rental or sale markets (not just for rice land), and production for specialized rice markets to meet more sophisticated consumer demand. Given the threat of climate change in many parts of Asia, environmental concerns and long-term sustainability are critical factors with regard to productivity enhancements.

- *Diversification of farming, particularly for those farmers whose scale of operations or land quality does not enable them to earn a livelihood from rice farming.* Indeed, such rural diversification has been an important source of higher productivity and a pathway out of poverty in most advanced countries and is an integral part of a successful structural transformation. Diversification means switching to high-value crops, livestock, and fish production in response to new consumer demands that are transmitted through modern supply chains. Many small farmers will need technical assistance from either the public or private sector if they are to respond successfully to these new opportunities.

- *Expansion of production of export commodities in light of current opportunities in the market value of several of the most important ones, especially rubber and palm oil, which reflects the new reality of scarce energy supplies.* Great care must be taken to manage this expansion so there is minimal clearing of existing forests and little diversion of water and fertilizer from food crop production to biofuel production. There is also an opportunity to improve the quality of the region's beverage crops, especially cocoa, coffee, and tea, which would quickly lead to higher incomes for the small farmers producing these commodities.

An improved rural investment climate that makes the formation and expansion of small and medium enterprises feasible, which requires addressing the following key constraints on investors:

- *The poor quality of infrastructure,* especially roads, which sharply limits the size of the market for rural enterprises and restricts their access to improved technologies.

- *Lack of access to formal financial institutions* is an important constraint on forming new rural enterprises, and improved access to credit would allow substantial expansion for this sector (including farms), often by 50% or more.

- *Local government barriers to rural investment,* including lack of regulatory transparency, corruption, and efforts to control the free movement of goods, services, and labor across provincial, state, and district boundaries. It may be difficult in an era of decentralization for national governments to enforce best practices on local governments, but those that cooperate will find their own economies growing faster.

Greater investment in higher quality rural human capital to provide a long-run solution to both economic growth and poverty reduction, whether in rural or urban areas, which requires:

- *Vastly improved schooling and provision for skill training* that meets local needs, with an emphasis on girls and women where they have been underserved.

- *Building and staffing rural public health facilities,* emphasizing delivery of pre- and postnatal care, together with a focus on early child development and nutritional support services.

- *Investing in national programs for leadership training at the local level,* which would pay high returns and would be an excellent venue for national-local partnerships.

Programs to Improve Nutrition and Individual Access to Food

Several key concepts now form the basis for addressing undernutrition. First, the priority is to focus on the period between conception and age 2, a critical window of opportunity for nutrition interventions. Second, simultaneous efforts to prevent malnutrition, as well as to treat moderate acute malnutrition, are essential. Third, nutrient quality in addition to food quantity matters, particularly for infants and young children at risk of undernutrition. Fourth, introducing new food products—fortified complementary foods, ready-to-use therapeutic and supplementary foods—into the diet is an important new advancement in tackling undernutrition. Finally, each context requires a careful review to determine the most appropriate food to be provided to ensure that the needs of specific groups are met, and how to most effectively and efficiently deliver the food and other program inputs in the particular setting. Hence, while increasing rice availability and improving household food security is essential, much more is needed to improve diet quality in terms of micronutrients, as well as other complementary interventions and actions.

Food Safety Nets

Poor and disadvantaged people who are highly vulnerable to food shortages require social safety net programs to ensure that their needs are adequately met. Both urban and rural poor people would benefit from food and/or income transfers and nutrition programs focusing on early childhood. Locally sourced school feeding programs also offer great promise in improving nutritional status of children. Safety nets are a subset of broader social protection systems. Safety nets mostly include noncontributory transfers and other interventions to improve access to food and basic essentials, such as price subsidies. Countries have different capacities to introduce and expand safety nets, which should be carefully considered in the design and implementation stage.

Evidence shows that safety nets stimulate growth in four ways. The first one concerns the accumulation of human capital. This includes direct investments in nutrition, for example through micronutrient supplementation. School feeding has been confirmed as a proven safety net and strategy to fight global hunger,[60] given its support to long-term investments in human capital by achieving nutrition, education, value transfer, gender equality, and wider socioeconomic benefits. Better nutrition among children may lead to higher income streams when they become adults, due to the combined effects of better cognitive development, school attainments, and labor productivity. In Cambodia, for example, the government has included school feeding as part of a national social safety net strategy, with the support of partners like WFP. Successful national school feeding programs in middle-income and

[60] At the G8 Summit in L'Aquila in July 2009; the high-level meeting on safety nets in Bellagio, Italy, July 2009; the 2009 World Food Summit in Rome; and during the UNESCO Education for All meeting in Addis Ababa in February 2010.

high-income countries tend to rely on local procurement of commodities, while programs in low-income countries usually find themselves dependent on external sources of food aid. However, efforts such as the Home Grown School Feeding Initiative, which focuses on linking school feeding programs with local small-scale farmer production by creating an ongoing market for small landholders, are increasingly underway.[61]

A second stream of "growth-friendly" safety nets is related to the adoption of higher-risk but higher-income livelihood options. This approach is rooted in the observation that farmers may underperform because of overly conservative business practices, and that they could be encouraged to shift towards more rewarding models. Safety nets could play an important role by guaranteeing a floor against which more risky strategies could be pursued. This strategy is particularly relevant in view of climate change adaptation, which inevitably involves changes in techniques and practices.

A third channel centers on alleviating some market failures. Examples include the deployment of labor-intensive schemes to build infrastructure that connects markets. Safety nets can provide transfers or insurance to liquidity-constrained households whose needs may not be met by market forces alone. An example is the Raskin program, a government-subsidized rice program for the poor, in Indonesia.

Finally, targeted programs can generate local economic multipliers, hence revitalizing ossified markets. Voucher programs in Kabul, Afghanistan, for example, allow access to commodities through preselected shops, creating an urban safety net program targeting the poor and supporting local markets. In Afghanistan, the number of internally displaced persons fleeing from conflict-affected areas to the capital has been significant, causing stress on the city's poor, limited, and often damaged infrastructure and resources. The city's population has tripled to nearly 5 million people, and many have settled in slums in and outside Kabul, creating numerous challenges to urban planning and recovery.

Well-designed safety nets can help reduce inequality, thereby complementing growth and market-oriented policies. The Vulnerable Group Development project, implemented by the government and partners in Bangladesh, is one such example; the project focuses on the nutritional status of malnourished women and children and aims at enhancing the income-earning capacity and self-reliance of ultra-poor and food-insecure women in order to ensure their graduation into mainstream development programs.

Programs to Prevent and Treat Undernutrition in Emergency and Development Contexts

There are a number of direct interventions with demonstrated ability to improve child and maternal undernutrition,[62] including exclusive and continued breastfeeding, optimal complementary feeding for children from 6-23 months, Vitamin A supplementation or

[61] WFP, NEPAD, the Bill and Melinda Gates Foundation, and other partners have together developed an approach to Home Grown School Feeding.

[62] TheLancet.com, "Maternal and Child Undernutrition" (January 2008), http://www.thelancet.com/series/maternal-and-child-undernutrition (accessed July 10, 2010).

fortification, community-based treatment of severe acute malnutrition, universal iodine supplementation, and hand washing or hygiene interventions. A recent study in Haiti also showed that fortified blended food can be used effectively to prevent stunting when it is provided to all children 6-23 months of age. Supplementary feeding in emergencies, development of new micronutrient fortification of cereals and other foods, and other health interventions such as immunizations, case management of acute respiratory infections, and malaria and tuberculosis/HIV prevention and therapy are also essential.

There have also been recent new developments in the nutrition field, specifically the development of lipid-based nutrient supplements and ready-to-use foods for nutrition purposes, as well as micronutrient powders. WFP, for example, has been working to improve the composition of fortified blended foods, including a reformulation of original corn-soya blend to include additional micronutrients, and the development of enhanced nutritional corn- and wheat-soya blend products (i.e., CSB++ and WSB++), which have an improved micronutrient profile, a reduced fiber level, the addition of milk powder (animal protein), a higher fat level, and a lower aflatoxin level (carcinogenic) to make it more palatable and nutritionally more suitable for young children under the age of 2.

In addition to these direct nutrition interventions, indirect responses are also needed to impact on the key underlying causes of undernutrition, including increasing access to food, increasing dietary diversity, and improving health care and education.[63] It is also essential to address the barriers caregivers face to increase the regular use of micronutrient-rich foods in child diets, including cost, time, and other inputs needed for preparation, feeding, and helping to support other interactions with their children.

The Role of Women

As with many crops in many parts of the world, women are key players in rice ecosystems, even in conservative areas of South Asia where women are often secluded on their homesteads. In a study by IRRI of 17 sites in eight Asian countries, women contributed at least 50% of the labor in all but five sites.[64] It takes between 95 and 270 labor days per hectare to cultivate rainfed lowland rice in various parts of Asia—the median of the 17 villages was 133 days per hectare—depending on factors such as variety, ecosystem, and technology. Women are most likely to be responsible for transplanting, weeding, harvesting, and threshing. On average, women contributed 55% of the labor needed for rice cultivation, although the extremes were 17% at one site in the Philippines and 84% at a site in India.

Women contribute the most labor in Laos PDR and in India, particularly in villages close to urban centers that men can easily migrate to for work. But in South Asia, rice

[63] Marie T. Ruel, "Addressing the Underlying Determinants of Undernutrition: Examples of Successfull Integration of Nutrition in Poverty-Reduction and Agricultural Strategies," *UN Standing Committee on Nutrition News*, no. 36 (2008): 21-29, http://www.unsystem.org/scn/Publications/SCNNews/scnnews36.pdf (accessed July 27, 2010).

[64] Data from IRRI, "Gender Analysis in Rice Farming Systems Research: Does It Make a Difference?" in *Report of the Women in Rice Farming Workshop*, held in Indonesia, June 4-8, 1990 (unpublished); IRRI, *Proceedings of the International Workshop on Gender Concerns in Rice Farming, Chiang Mai, Thailand, October 22-25, 1992* (Manila: IRRI, 1992).

production labor is segmented. For example, in Chandpur, eastern Uttar Pradesh, higher caste women provide almost no labor to family rice production, but their families hire female labor such that women are responsible for 87.5% of the total labor for rice production. In backward and scheduled castes they are still responsible for about 84% of labor in rice production, but some of this is on their own family plots.[65] Backward and scheduled castes predominate among the poor, and hence many women work outside of the homestead. Thus gender analysis is critical to improving rice productivity without further impoverishing poor rural women.

In many parts of Asia, as opportunities develop in towns and cities, women assume a greater role in farming. It is estimated that around 50% of the rice farmers in the Philippines are now female, more than one-third of the female agricultural workforce. Yet women account for less than one-third of the beneficiaries of government programs, with the exception of credit from the Agricultural Credit Policy Council where they are close to half. Women are less likely to have title to land, and in 2002 just 22% of the beneficiaries of agrarian reform were women.[66]

The role of women in food security in Asia extends well beyond their role in food production and in household food preparation and distribution. Women can and do play leadership roles in their local communities and beyond, and these broader roles need to be encouraged while active steps are being taken to help women gain access to land and water resources, agricultural inputs and finance, extension services, and marketing facilities.

[65] Thelma Paris, Abha Singh, Mahubub Hossain, and Joyce Luis, "Using Gender Analysis in Characterizing and Understanding Farm-Household Systems in Rainfed Lowland Rice Environments," in Characterizing and Understanding Rainfed Environments: Proceedings of a Workshop, eds. T. P. Tuong, S. P. Kam, L. Wade, S. Pandley, B. Bouman, and B. Hardy (Manila: IRRI, 2001).

[66] Jessica Reyes-Cantos and Riza Bernabe, "Gender and Rice: The Case of the Philippines," International Gender and Trade Network, December 2006, http://genderandtrade.org/gtinformation/164419/164436/169807/filipino_women_in_the_rice_industry/

Conclusion: The Steps Ahead

The Asia Society/IRRI Task Force recognizes the enormous amount of effort from earlier studies that has gone into understanding and improving food security at the global, regional, national, and local levels. As outlined earlier in this report, there are a number of key measures related to food security already underway.

To complement and reinforce those efforts, the Task Force proposes a series of actions to secure Asia's food security going forward. As developed in previous sections, these actions fall into four main areas:

1. **The steps needed to raise the productivity of Asia's rice farmers in ways that conserve water, land, and energy-intensive inputs while also building resilience to the expected impact from climate change.**
2. **The steps needed to improve the economic environment for rural development, including farm and non-farm activities, at local, national, and regional levels, with renewed attention to how to stabilize domestic food economies.**
3. **The steps needed in the short run to ensure that the rural and urban poor have access to nutritious foods and know how to utilize them, including the provision of safety nets so that they can lead productive lives even in the face of significant risks and vulnerabilities.**
4. **The steps needed to ensure that regional public goods in the broad arena of sustainable food security are adequately provided.**

There are also four levels at which these actions need to be taken:

1. **The private sector,** including small farmers, must carry out about 90%-95% of all the activities that will bring about sustainable food security in Asia.[67] Bringing the private sector "on board" to ensure food security will require new and innovative public-private partnership arrangements.
2. **Non-governmental organizations and international institutions** with interests in agricultural development and food security, such as the Bill and Melinda Gates Foundation, the Rockefeller Foundation, the Ford Foundation, the World Food Program, and the Food and Agriculture Organization of the United Nations, among others.

[67] The quantitative role of the private sector is calculated on the basis of the following assumptions: The gross size of the Asian rice economy at the retail level is about $160 billion. This is composed of $100 billion in value added at the farm level, which is all private; $20 billion in purchased inputs, plus implicit value of water from irrigation systems, which is half private and half public; and $40 billion in marketing costs, of which $2 billion is carried out by the public sector. Thus the private sector role works out to 92.5% of the total. An additional public role, not calculated in the value indicated here, would involve the subsidies for rice consumption that are widespread in Asia.

3. **International financial institutions** (IFIs) with active lending and advisory programs in this arena, such as the World Bank, the Asian Development Bank, and the International Monetary Fund.

4. **Individual countries** in the region, where policies and programs within their borders are the primary mechanisms for affecting farm production, food marketing, and consumption. Several countries are large enough that their domestic policies for food security have regional and global impact, and finding a mechanism to coordinate these policies has high priority.

Part of the problem is that there is currently no effective coordinating mechanism in the arena of food security to ensure that actions taken by institutions at these four levels are complementary and not competitive. Indeed, the fact that many of the food security issues addressed in this Task Force report result from systemic problems that are beyond the capacity of individual countries to solve, and also beyond the mandate of regional and global institutions to solve, suggests the need for a new approach to the provision of regional (and global) public goods. At the same time, the global, national, and local business communities are constantly making investment decisions in this imperfect world that affect food security in both the short run and long run—from research on agricultural technologies, to farm inputs and outputs, to supply chain investments that reach all the way to consumers. A new approach to understanding and coordinating these decisions is needed.

Task Force Recommendations: Sustaining Food Security in Asia

The following outline summarizes: (1) the steps that need to be taken between now and 2030 to ensure that food production in general and rice production in particular are adequate for all Asians to have nutritious food available in markets; and (2) the measures required to ensure that all Asians have access to this food and utilize it effectively. Each of these recommendations is analyzed and developed in the main body of the report.

Raising and Sustaining the Productivity of Rice Farmers

Increased investments are needed to revitalize research and development efforts on raising the yield potential of rice, and to enable more systematic inclusion of grain quality into rice breeding for specific target markets. Although hybrid rice has made some progress in this regard, its spread has been rather limited. But given recent developments, it seems likely that proprietary rice hybrids and genetically modified varieties will see significantly wider diffusion in the coming decade, especially in Asia. The public sector can support this through R&D that focuses on providing elite germplasm and traits for commercial hybrid rice efforts, and it will likely continue to play the leading role in inbred breeding. An ambitious program on breeding C4 rice with up to 50% higher yield potential was recently started. It will require far larger investments than at present, sustained over 20 years. However, no other technology would offer a comparable breakthrough potential.

The private sector's involvement in rice research and extension services that bring new techniques and technologies out into the field is needed to raise productivity growth. While public sector rice breeding and biotechnology research probably still has far more resources, private sector rice research has grown very rapidly from a small base in the last two decades. Larger and longer-term commitments to support research by the private sector on grand challenges and international public goods, as well as increased support of public sector research aimed at advancing high aggregate potential benefits, are crucial, especially given the lack of immediate commercial potential. Basic research is needed in such areas as engineering of advanced photosynthesis mechanisms into rice, biological nitrogen fixation in rice, insect-virus interactions, and sustainability indicators for key ecosystem services.

The following six areas of research will cost approximately $60 million additional funding in 2010, rising to about $100 million per year by 2015.[68]

- Strengthen and upgrade the rice breeding and research pipelines (including a nutrition focus);
- Accelerate research on the world's thousands of rice varieties;
- Develop a new generation of rice scientists and researchers for the public and private sectors;
- Bring about an agronomic revolution in Asian rice growing;
- Design new systems to integrate high-yield rice and production of other crops; and
- Improve postharvest technologies for rice.

The Task Force strongly encourages public-private partnerships to carry out this research. To fund this research, the Task Force recommends an innovative new arrangement with similarities to a very successful funding mechanism developed in Brazil. There, the entire rice research and extension system in the state of Rio Grande do Sul is paid for by farmers, through a check-off system (20 cents per bag of rice produced = about $30 million per year). Rice yields have increased in the past 6-7 years at rates 4-5 times the world average, on over 1 million hectares of irrigated land. The system has three main advantages: research is focused on what farmers want, research funding benefits from increasing yields, and research funding (and the research itself) is independent from political fluctuations.

An alternative to the farmer check-off system, but with a similar philosophy, could work in Asia, where farm size tends to be very small. National commitments to fund rice research on the basis of the value of domestic rice production would certainly be a step forward, and public funding would signal a recognition that consumers benefit at least as much as farmers from gains in rice productivity. The approach would need to allocate a small percentage of such a fund to the international institutions that carry out rice research, such as through

[68] These figures are based on IRRI estimates contained in the Global Rice Science Partnership program proposal.

the Consultative Group on International Agricultural Research (CGIAR). It is important that Asia participate significantly more in the funding of research on its basic food crops, especially rice. A production-based system would focus the incentives where they are most effective—long-run research on raising productivity in a sustainable fashion.

As a rough example of the possible sums involved, consider a base production of rice in Asia of about 400 million metric tons, worth about $300 per metric ton, for a total production (farm-level) value of $120 billion per year. A levy of 0.5% on the value of rice production would thus yield about $600 million per year to be allocated to rice research. Perhaps 10% of this should be devoted to the international centers conducting rice research, thus guaranteeing them about $60 million per year in regular funding (and leaving $540 million per year for in-country rice research programs). This would be considered "core," or unrestricted funding to be used for long-run research, provision of modern facilities, and regional training programs.

Improving the Environment for Rural Development

Stimulating rural development in a way that includes the landless and smallholder farmers is a huge task that is at the core of overall development strategies. It is also a task that in the past has often overlooked female farmers and workers. This report does not make specific recommendations on how any particular country should go about this task, apart from the previous discussion of the seven topics listed below, but it does urge the global donor community to continue to put agricultural development back on its funding agenda and to engage with both men and women. Higher agricultural productivity is the essential foundation to broader gains in the rural economy and from there to overall economic development. Specific recommendations on stabilizing food prices and establishing a more open trade regime for rice are presented because so little attention has been paid to these topics in the past two decades:

- Invest in agricultural infrastructure and information systems;
- Reform the policy environment for food markets;
- Stabilize food prices;
- Build capacity of both male and female smallholder farmers to access markets;
- Connect macro policy to micro decision makers;
- Link agricultural development strategies to the rural poor; and
- Strengthen the rural non-farm economy.

Commodity experts who are not familiar with the unique institutional dimensions for rice price formation and trade are surprised to learn that price discovery is "opaque," with no publicly quoted prices available on a daily basis. Futures markets for rice are so

thinly traded as to be useless for hedging risks facing market participants. Even very large import orders by public agencies are often negotiated privately, with the terms unavailable to interested citizens. Not only is rice risky to grow, it is risky to sell and trade. Is there any way to lower risks in the Asian rice economy?

One proposal to build confidence in the world rice market was presented at the ADB/FAO/IFAD Food Security Investment Forum in Manila in early July 2010, and involves increasing the level of rice reserves in all levels of the rice economy, especially in the large Asian countries with a deep interest in more stable rice prices.[69] Larger reserves will be expensive to build and maintain, but the goal is not to use increased reserves to provide for growing demand for rice, but to cushion price shocks and help country policy makers have more confidence in using the world rice market—imports and exports—as a routine source of supply and demand. More open trade would actually help stabilize rice prices and thus undermine the need for larger reserves. A new equilibrium could be reached with more stable rice prices and efficient use of trade to smooth out shocks to production and consumption.

An alternative proposal would be to establish a robust futures market for rice, perhaps in Singapore, with a focus on a single quality standard widely traded in Asia—perhaps 25% broken long-grain rice that could be sourced from the main exporters. Considerable analysis would be needed to determine the appropriate institutional mechanisms so that private traders would feel confident in participating in such a rice futures market, as both hedgers and speculators. Under normal circumstances, a robust and deep rice futures market should add substantial stability and transparency to formation of rice prices, which in turn would help build confidence in the reliability of the world rice market. Some words of caution: the successful development of a commodity futures market depends heavily on the legal structure of the contracts (and their perceived enforceability) and on access to modern financial markets to provide the underlying liquidity that makes a futures market useful to traders. Singapore seems a logical place for a rice futures market because it can satisfy these criteria.

Successful futures markets are normally privately financed and do not depend on continuing public subsidies. Still, establishing some of the foundation instruments needed for a successful futures market to operate—such as a modern financial system, commodity trading mechanisms, and clear and enforceable grades and standards—often requires active public participation in the early stages. A high-level commission might also be pulled together to evaluate the potential for a rice futures market and to provide impetus to its development.

Providing Safety Nets and More Nutritious Foods to the Poor

A rich portfolio of experiments to provide efficient and effective food safety nets has been underway for the past several decades, although only a few countries have managed to operate them at national scale. Conditional cash transfers seem to be evolving as best

[69] For example, C. Peter Timmer, "Fostering Food Security through Regional Cooperation and Integration: The Changing Role of Rice in Asia," presented to the ADB/FAO/IFAD Food Security Investment Forum, Manila, the Philippines, July 7-9, 2010.

practice in this area, although in poor and remote regions without smoothly functioning food markets, there clearly remains a role for programs that physically deliver food to needy families. It will also be important to design programs that incorporate the special role of women in food security in Asia.

The recent food price crisis has tempered some of the "silver bullet" approach of the cash transfers community. In periods of rapidly escalating food prices, governments and implementers were unable to respond to protect the real value of cash transfers. In some countries, such as Ethiopia, beneficiaries asked to switch back to food transfers. Additionally, food transfers may be more important for the elderly, sick, and disabled who have less access to markets, or for those who require specialized foods (e.g., HIV patients, severely malnourished children). However, safety nets are more effective when designed prior to a crisis and when they are a component part of a comprehensive strategy to address social protection can be scaled up when crisis strikes. For this reason, it is recommended that all countries undertake systematic risk and vulnerability assessments that enable design of comprehensive systems of social protection for their citizens.

A social protection strategy is based on a complete identification of the various risks to which people are exposed, the level of associated vulnerability for different population groups, and an identification of the different social protection instruments that can be used to reduce the vulnerability of people to shocks that do occur. While the instruments may be publicly provided or facilitated, they are not always totally publically funded. Insurance instruments are often used within social protection strategies—often contributory depending on income level—to mitigate health shocks, unemployment, or old age. As such, these instruments also feature an element of redistribution where the wealthier are subsidizing the poorer by virtue of paying higher contributions. Even in the face of domestic funding constraints, the provision of social protection is a progressive action, laying out a strategy for nascent contributory programs. Publicly funded safety nets, as one element of social protection, are a significant contributor to economic growth. Such systems allow citizens to take on appropriate risk and invest productively for themselves and their families.

Complementary to safety net programs that protect the poor and their human capital are increased investment in better health and nutrition service delivery, as well as investment in formal education. The returns to such investments, especially for the rural poor, are very high. Use of improved health, nutrition, and education services can be catalyzed through conditional cash transfers, which not only improve service utilization but, because often the money goes into the hands of women, result in more household expenditures on food and human capital. They may not pay off directly in cash flow to the sponsors of the safety net programs themselves, but they clearly pay off to the society in the form of faster, and more equitable, economic growth. Evidence indicates that individuals lose up to 10% of lifetime productivity and countries can lose 2%-3% of GDP as a result of undernutrition. We suggest that investments in health and nutrition services delivery target the following:

- Design and implement cost-effective safety nets for food assistance for the rural and urban poor
- Implement programs to prevent and treat undernutrition in emergency and development contexts
- Design programs that incorporate the special role of women in food security in Asia

Recently an extensive costing exercise was carried out with regard to nutrition interventions. This was based on implementing 13 interventions (in three core groups) to 90% of the target children, recognizing that coverage of the last 10% is difficult in the 36 countries with the highest burden of undernutrition. These countries represent 90% of all stunted children. The three groups of interventions are:

- Behavior change interventions, including the promotion of breastfeeding and complementary feeding for children 6 to 23 months; and proper hygiene, with an emphasis on hand washing.
- Micronutrient supplementation and deworming for children under 5, including periodic Vitamin A supplements, deworming drugs, multiple micronutrient powders, and zinc for treatment of diarrhea. For pregnant women, iron supplements and iodized oil capsules should be provided where iodized salt is not available. For the general population, iron fortification of staple foods and salt iodization should be made available.
- Complementary and therapeutic feeding, including the provision of micronutrient fortified and/or enhanced complementary foods for children 6 to 23 months old to prevent and treat moderate malnutrition. Community-based management of severe acute malnutrition of children under 5 years of age should be provided.

The overall worldwide cost for scaling up nutrition programs is estimated to be $11.8 billion. However, the cost for South Asia alone is 50% of this at $5.9 billion, with a further $1.07 billion for East Asia and the Pacific.[70] These figures indicate the massive scale of the problem facing South Asia, and Asia more broadly, with regard to nutrition.

Provisioning Regional Public Goods for Food Security

To ensure that activities to provide the public goods needed in the three crucial recommendations above are widely communicated and, to the extent possible, effectively coordinated, the Task Force recommends that a Center for the Coordination of Food Security Activities in Asia be established within an already existing Asia-based institution —the Regional Office for Asia and the Pacific of FAO and the Asian Development Bank

[70] Horton, Susan, Meera Shekar, Christine MacDonald, Ajay Mahal, and Jana Krystene Brooks, *Scaling Up Nutrition: What Will It Cost?* (Washington, DC: World Bank, 2010).

are obvious possibilities. The first step towards establishing this Center would be to assess existing food security-related efforts being led by regional and sub-regional groups, examine how these services are being provided, and identify the constraints and gaps in their efforts. As part of this assessment, regional policy makers should initiate discussion forums with private sector leaders, non-governmental organizations, and other key stakeholders on the effective provisioning of regional public goods for food security.

Following this assessment, the Center should be equipped with the resources to access timely information on food production, trade and prices, and consumption (and would make this information widely and freely available); monitor policy and program initiatives at the country and regional level (and issue regular policy briefs and updates); and conduct its own evaluations of the impact and cost effectiveness of food security strategies in the region. A specific part of its mandate would be to document the systemic nature of long-run food security challenges in Asia and to identify appropriate systemic approaches to these challenges to strengthen or complement existing efforts in the region. The Center would need high-level links to research centers in the region that are engaged in analysis of food security issues. These links could be mediated via regular exchanges of analysts and scholars, which could also be used to support regional training programs in food security. Our suggestions for providing public goods to support food security are as follows:

- Agricultural research (Consultative Group on International Agricultural Research, national agricultural research systems, the private sector)
- Open and stable food markets (World Trade Organization, regional trade agreements)
- Responses to climate change (Kyoto and Copenhagen, individual country responses)

Financial Dimensions

New money is going to be needed every year to achieve sustainable food security in Asia. The United Nations estimates that an additional $40 billion dollars per year would be needed—on top of the $80 billion currently being spent on agricultural development, poverty reduction, and food security—to eliminate hunger and poverty in Asia by 2050. An additional $12 billion per year will be needed to scale up programs to eliminate malnutrition. At a more focused level, IRRI estimates that an annual investment of $120 million between 2010 and 2030 could increase rice productivity by 8.5% (above "business as usual" trends) over the next 25 years, which could lower the poverty rate in Asia by 15% and the hunger rate by 20%. There are no other visible investments with that kind of impact on hunger and poverty.

Where will this money come from? The world food crisis of 2007-08 has clearly put food security back on the agenda of the broader donor community. Major commitments of new funding have been made, but no careful analysis has yet been done of when the committed funding is likely to be available, on what terms, and for what purposes. Recent "food security investment forums" at the country level have begun to specify in considerable

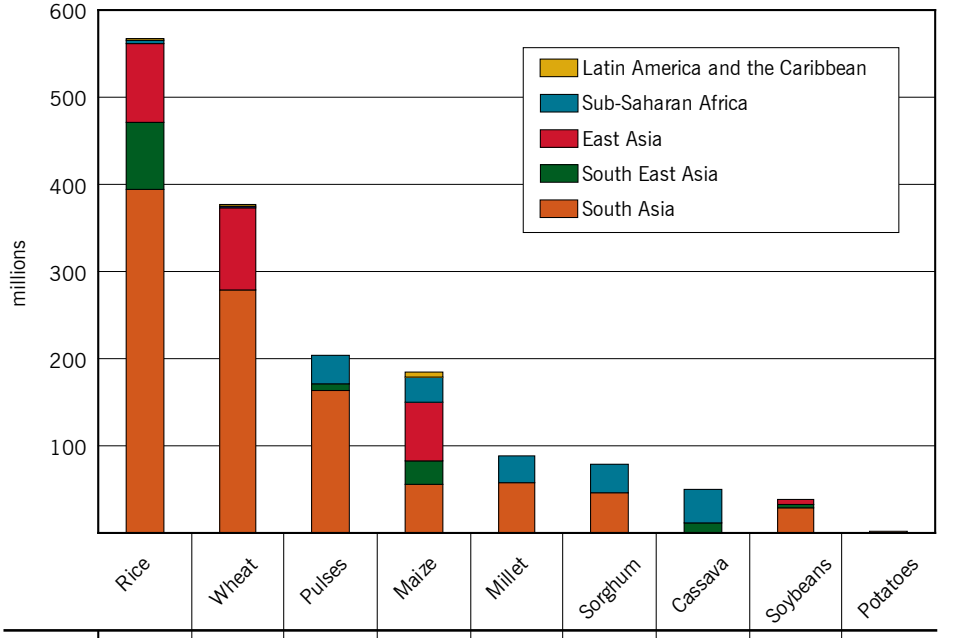
detail the likely resources needed, but only Bangladesh has so far managed to produce a detailed plan of action and begun to raise the resources needed to fund it. On the basis of this plan, Bangladesh was the first country in Asia to qualify for funding from the new Global Agriculture and Food Security Program (GASFP). Finding ways to make the GASFP process flexible, efficient, and accessible should be a high priority.

Developing strong partnerships with the private sector will bring about better understanding of this important sector's investment plans in areas that affect food security, from input technologies to development of modern supply chains, to food technologies that change the range of products available to consumers. In aggregate, the entire agribusiness system that provisions the global food economy is the largest industry in the world. Virtually all of the funding for this system comes, of course, from food consumers. Other funding sources—foundations, international financial institutions, philanthropic individuals—will be crucial for moving forward the food security agenda, but it is important to realize where this funding fits in the larger global food economy.

Finally, it is worth re-emphasizing the crucial need for individual countries to raise enough revenues domestically to fund their own rice research activities, with modest contributions to global agricultural research as a public good. Country-based funding will also provide the great majority of support for safety nets, school feeding programs, and initiatives to bring women into a more prominent role in providing food security at the household, village, national, and global levels.

Appendix 1

Number of people, in millions, below the $1.25 per day (PPP) poverty line who live in areas dominated by different crops.[71]



	Rice	Wheat	Pulses	Maize	Millet	Sorghum	Cassava	Soybeans	Potatoes
South Asia	394.5	279.0	163.6	56.2	57.4	47.0	0.7	28.8	0.8
South-east Asia	77.3	–	7.3	26.0	–	–	11.2	3.7	–
East Asia	88.8	94.9	1.0	68.7	0.1	0.04	–	5.6	1.1
Sub-Saharan Africa	5.2	2.0	31.3	27.6	31.6	31.9	38.2	0.1	0.7
Latin America and the Caribbean	0.8	0.26	0.8	5.5	–	0.5	0.3	0.7	0.05
TOTAL	**566.6**	**376.2**	**204.0**	**184.0**	**89.1**	**79.4**	**50.4**	**38.9**	**2.6**

[71] Data from 2005. Numbers are based on areas more than 10% covered by the dominant crop. Some areas have more than one dominant crop and thus overlap.

Biographies of Task Force Members

Co-Chair

Dan Glickman is a Senior Fellow at the Bipartisan Policy Center in Washington, DC. Previously, he served as President of Refugees International and as Chairman of the Motion Picture Association of America (MPAA). From 1995 to 2001, he was U.S. Secretary of Agriculture. During his tenure, he made significant contributions to food and nutrition issues. He served for 18 years in the U.S. House of Representatives representing the 4th Congressional District of Kansas. During that time, he was a member of the House Agriculture Committee, including six years as chairman of the subcommittee with jurisdiction over federal farm policy issues, and the chairman of the House Permanent Select Committee on Intelligence.

Co-Chair

M.S. Swaminathan is a Member of Parliament in India's Rajya Sabha (upper house) and the founder and Chairman of the M.S. Swaminathan Research Foundation in Chennai (Madras), India. A plant geneticist by training, he is widely referred to as the scientific leader of Asia's Green Revolution for his leadership in introducing and further developing high-yielding varieties of wheat in India. He has been acclaimed by TIME magazine as one of the twenty most influential Asians of the 20th century. He received the Ramon Magsaysay Award for Community Leadership in 1971, the Albert Einstein World Science Award in 1986, and the first World Food Prize in 1987. He is a member of the Royal Society of London and the U.S. National Academy of Sciences.

Members

Vishakha N. Desai is the sixth President and CEO of the Asia Society, a leading global organization committed to strengthening partnerships among the people, leaders, and institutions of Asia and the United States. She sets the direction for the Society's diverse programs, ranging from major US-Asia policy initiatives and national educational partnerships for global learning, to ground-breaking art exhibitions and innovative Asian American performances. Prior to assuming her current position in 2004, she held several positions at the Asia Society, first as Director of its Museum, and then as Vice President for Arts and Cultural Programs and Senior Vice President. Before joining the Asia Society in 1990, she was a curator at the Museum of Fine Arts Boston and the head of Public Programs and Academic Affairs.

Henrietta H. Fore is Chairman and CEO of Holsman International, an investment and management company involved in domestic and international business. From 2007 to 2009, she served as the first female Administrator of the U.S. Agency for International Development (USAID). Additionally, she was designated as the Director of U.S. Foreign Assistance, holding the equivalent rank as Deputy Secretary of State. She served as the thirty-seventh Director of the U.S. Mint in the Department of Treasury from August 2001 to August 2005. Ms. Fore is a Trustee of the Asia Society.

Noeleen Heyzer is the ninth Executive Secretary of the United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP) and is the first woman to hold this position since its founding in 1947. Previously, she served as the first Executive Director from the South to head the United Nations Development Fund for Women (UNIFEM). She has received numerous awards for leadership, including the Dag Hammarskjöld Medal in 2004. In recognition of her contribution to women, peace, and justice, she was among the nominees for the Nobel Peace Prize in 2005.

Jikun Huang is the founder and Director of the Center for Chinese Agricultural Policy of the Chinese Academy of Sciences and a professor at the Institute of Geographical Sciences and Natural Resources Research. His research covers a wide range of issues on China's agricultural and rural development, including work on agricultural R&D policy, price and marketing, food consumption, and trade policy. He has received a number of awards from China's government, including on four occasions the Outstanding Scientific Progress award from the Ministry of Agriculture.

N.R. Narayana Murthy is the founder and Chairman of Infosys Technologies, a global software consulting company headquartered in Bangalore, India. He is known for designing and implementing the Global Delivery Model, which has become the foundation for the huge success in information technology services outsourcing from India. He serves on numerous boards, including HSBC, the Ford Foundation, the United Nations Foundation, Cornell University, and the Wharton School, among others. He has been awarded the Padma Vibhushan by the Government of India and the Legion d'honneur by the Government of France, and made a Commander of the Order of the British Empire.

Ong Keng Yong is the Director of the Institute of Policy Studies at the National University of Singapore's Lee Kuan Yew School of Public Policy. He is concurrently serving as Ambassador-at-Large in the Singapore Ministry of Foreign Affairs and Singapore's Non-Resident Ambassador to Iran. Prior to his current positions, he was the Secretary-General of the Association of Southeast Asian Nations (ASEAN) from 2003 to 2008. He was awarded the Public Administration Medal in 1997, the Long Service Medal in 2002, and the Meritorious Service Medal in 2008 by the Singapore Government.

Judith Rodin is President of the Rockefeller Foundation, a position she has held since 2005. She was previously president of the University of Pennsylvania, where she presided over an unprecedented decade of growth and progress. As Chair of the Department of Psychology and Provost at Yale University, she was widely recognized for her ground-breaking research in obesity, eating disorders, aging, and women's health—work that earned her the American Psychological Association's Distinguished Early Career Award in 1977 and its Distinguished Lifetime Contribution Award in 2005.

Ursula Schaefer-Preuss is Vice-President for Knowledge Management and Sustainable Development at the Asian Development Bank (ADB). She is responsible for ADB's Regional and Sustainable Development Department and Economics and Research Department (Office of the Chief Economist). Prior to joining ADB, she was the Director General of the Federal Ministry for Economic Cooperation and Development in Bonn/Berlin, Germany.

Josette Sheeran is the eleventh Executive Director of the United Nations World Food Programme (WFP), a position she has held since April 2007. As the leader of WFP, she oversees the world's largest humanitarian agency fighting hunger worldwide. She also is currently serving a two-year term as Chair of the High-Level Committee on Management, which ensures coordination and coherence in administrative and management areas across the entire UN system. Previously, she served as Under Secretary for Economic, Energy and Agricultural Affairs at the United States Department of State.

Vichai Sriprasert is Honorary President of the Thai Rice Exporters Association, a membership organization which aims to reinforce the competitiveness of Thai rice in the world market and supports the creation of a stronger rice industry in Thailand. He is also Chief Executive Officer of Riceland International Limited, a leading rice exporting company based in Bangkok, Thailand, with international markets in Africa, Europe, and the Middle East. Previously, he served as President of the Thai Rice Exporters Association. He is a frequent commentator in the media on the world rice market and trade.

James D. Wolfensohn is the Chairman of Wolfensohn & Company, a private investment firm, and an advisor to corporations and governments. He served as the President of the World Bank from 1995 to 2005 and was concurrently the President of the International Finance Corporation. He is the Chairman of the International Advisory Board of Citigroup, Inc., and Chairman of the Advisory Group of the Wolfensohn Center for Development, a new research initiative focused on global poverty, at the Brookings Institution.

Robert Zeigler became Director General of the International Rice Research Institute (IRRI) in 2005. He is an internationally respected plant pathologist with more than 30 years of experience in agricultural research in the developing world. He previously worked at IRRI from 1992 to 1998, leading the Rainfed Lowland Rice Research Program and then later the Irrigated Rice Research Program. He is the chairman of the board of directors of the Association of International Agricultural Research Centers (AIARC).

Suzanne DiMaggio (Project Director) is the Director of Policy Studies at the Asia Society, where she oversees the Society's task forces, working groups, and Track II initiatives aimed at promoting effective policy responses to the most critical challenges facing the United States and the countries of Asia. She directs the Society's Working Group on US-Iran Relations, the Task Force on US Policy toward Burma/Myanmar, and the Leadership Group on Water Security in Asia. She previously served as the Vice President of Global Policy Programs at the United Nations Association of the USA (UNA-USA).

C. Peter Timmer (Principal Advisor) is a leading authority on agricultural development and structural transformation during the process of economic growth. He has served as a professor at Stanford, Cornell, Harvard, and the University of California, San Diego, where he was also the Dean of the Graduate School of International Relations and Pacific Studies. A core advisor to the World Bank's World Development Report 2008, he has long worked with a number of Asian governments on domestic food and agricultural policies and on their responses to the global rice market crisis. He advises the Bill and Melinda Gates Foundation on agricultural development issues.

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