Food Security in Asia and the Pacific

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Foreword

Food security is complex. It is primarily built on three pillars: (i) food availability—sufficient quantities on a consistent basis; (ii) food access—the ability to obtain adequate and nutritious food; and (iii) food utilization—satisfying dietary needs and cultural preferences.

In Asia and the Pacific, food security is being fundamentally altered, as patterns of food consumption and production change alongside global trends—like climate change—in sustaining agricultural output. Providing enough safe and nutritious food remains a serious challenge for the region. The dynamics of food security are changing fast. However, after 2 decades of stunning economic growth, rapid reduction in absolute poverty, expanding urbanization, industrialization, and a rising middle class, the region is still home to more than 60% of the world's hungry.

After years of relatively stable real food prices, the 2007–2008 global price hikes in food staples brought the issue of food security higher up the global agenda. Aside from having direct effects on poverty incidence and nutrition, the dramatic increase in food prices and volatility had a negative impact on the overall economy. Food price inflation can trigger demands for wage increases, igniting a vicious inflationary cycle that could discourage private investment and slow economic activity. Given the importance of food in household budgets, insecurity reduces investment in education and health, and can damage a country's human capital and long-run growth prospects.

With the aim of identifying viable policy options, the Asian Development Bank, in collaboration with Foreign Affairs, Trade and Development Canada (formerly, the Canadian International Development Agency); the Asia-Pacific Economic Cooperation; and the Liu Institute for Global Issues at the University of British Columbia, initiated a research project in 2012 to deepen the understanding of food security in Asia and the Pacific. Fourteen background papers were commissioned as part of this project to investigate food security issues particularly pertinent for Asia and the Pacific.

This synthesis report collates the key findings from these papers. The report highlights the need to reduce poverty and ensure the sustainability of global food systems. It analyzes the relationship between poverty, nutrition, and access to food. It examines competing demands for available resources, and ways to boost productivity amid changing demand and supply. It looks at trade, logistics, and possible effects of climate change. It also explores some practical policy options to deal with the food security challenges in Asia and the Pacific. Perhaps most usefully, however, the report aims to stimulate discussion

on the various approaches to achieving food security—without sacrificing the resources needed for the next generation. Just as food security is central to our development efforts, sustainable development is the only path for our children's future.

Changyong Rhee
Chief Economist
Asian Development Bank

Acknowledgments

This synthesis report is the result of close, collaborative research initiated by the Asian Development Bank (ADB) in partnership with Foreign Affairs, Trade and Development Canada (DFATD); the Asia-Pacific Economic Cooperation (APEC); and the Liu Institute for Global Issues at the University of British Columbia (UBC). The collaboration was designed to further understand, synthesize, and articulate key policy challenges and opportunities related to food security in the Asia and Pacific region, as well as to contextualize the role and importance of the region on the global stage. It explores the web of issues linking food security to food access and availability, and its impact on nutrition and poverty. It also examines the effects of the evolving socioeconomic environment surrounding rapid structural changes and urbanization in the region, competing demand for natural resources, and climate change on food supply and demand. Appropriate policies and interventions could then be considered to help steer the region's development toward a more sustainable path.

The research was coordinated by the ADB Economics and Research Department under the overall guidance of Assistant Chief Economist Cyn-Young Park, in consultation with Paul Samson, Partnerships with Canadians Branch of DFATD, and the Liu Institute for Global Issues at UBC. The synthesis report was written by Cyn-Young Park, Utsav Kumar, and Emmanuel San Andres with invaluable contributions from Peter Warr, ADB consultant for the project. Marianne Joy Vital provided excellent research assistance.

The report synthesizes and collates 14 research papers written in preparation for the Symposium on Food Security in Asia and the Pacific: Key Policy Issues and Options, held on 17–18 September 2012 at the Liu Institute for Global Issues, UBC. These background papers investigated food security issues particularly pertinent for Asia and the Pacific, ranging from changing demand and increasingly constrained agricultural resources and supply potential, to evolving food value chains.

The authors of the background papers are Lourdes S. Adriano, Pramod Aggarwal, Douglas Brooks, Bruce Campbell, Kevin Chen, Jalal Chowdhury, Ramon Clarete, Merle Faminow, Benno Ferrarini, Eugenia Go, Himanshu, Hyeon-Seung Huh, Pramod Joshi, Shikha Jha, Milind Kandiklar, Ashok Kotwal, Patti Kristjanson, Kensuke Kubo, Hyun-Hoon Lee, Dennis Mapa, Bart Minten, Jennifer Mohamed-Katerere, Lynette Neufeld, Cyn-Young Park, Sharon Faye Piza, Navin Ramankutty, Bharat Ramaswami, Thomas Reardon, Emmanuel San Andres, Mark Smith, Mercedita Sombilla, Hyun H. Son, Sonja Vermeulen, and Annie Wesley.

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Abbreviations

4Ps	Pantawid Pamilyang Pilipino (Filipino Family Assistance) Program
ADB	Asian Development Bank
AFSIS	ASEAN Food Security Information System
AFTA	ASEAN Free Trade Area
AIFS	ASEAN Integrated Food Security
APEC	Asia-Pacific Economic Cooperation
APTERR	ASEAN Plus Three Emergency Rice Reserve
AR4	The Fourth Assessment Report of the IPCC
ASEAN	Association of Southeast Asian Nations
ASTI	Agricultural Science and Technology Indicators
BIPI	bilateral import penetration index
BLT	Bantuan Langsung Tunai (Direct Cash Assistance)
cc	climate change
CEES and CIS	Common European Economic Space and the Commonwealth of Independent States
CFA	Comprehensive Framework for Action
CFS	Committee on World Food Security
CO_2	carbon dioxide
CPI	consumer price index
DFATD	Foreign Affairs, Trade and Development Canada
FAO	Food and Agriculture Organization of the United Nations
FAOSTAT	FAO statistical database
FDI	foreign direct investment
G8	Group of Eight
G20	Group of Twenty
GDP	gross domestic product
GHG	greenhouse gas
GIS	geographic information system
HHI	Herfindahl–Hirschman Index
ICT	information and communication technology
IFPRI	International Food Policy Research Institute
IPCC	Intergovernmental Panel on Climate Change
IRRI	International Rice Research Institute
ISPAM	IFPRI Spatial Allocation Model
LAC	Latin America and the Caribbean
Lao PDR	Lao People's Democratic Republic
Macau SAR	Macau Special Administrative Region of the People's Republic of China
MDGs	Millennium Development Goals
MENA	Middle East and North Africa
MUV	Manufactures Unit Value
NFA	National Food Authority

Abbreviations

OECD	Organisation for Economic Co-operation and Development
PDS	Public Distribution System
PNG	Papua New Guinea
PPP	purchasing power parity
PRC	People's Republic of China
R&D	research and development
SPA-FS	Strategic Plan of Action on Food Security in the ASEAN Region
SSA	Sub-Saharan Africa
TFP	total factor productivity
TIPI	total import penetration index
UBC	University of British Columbia
UN	United Nations
UN Comtrade	UN Commodity Trade Statistics Database
UNESCAP	UN Economic and Social Commission for Asia and the Pacific
UNESCO	UN Educational, Scientific and Cultural Organization
US	United States
WDI	World Development Indicators
WFP	World Food Programme
WHO	World Health Organization
WTO	World Trade Organization

Weights and Measures

°C	degree Celsius
cm	centimeter
cm/decade	centimeter per decade
gr	gram
gr/capita/day	gram per capita per day
$GtCO_2e$	gigatons (billion tons) of carbon dioxide equivalent
ha	hectare
ha/capita	hectare per capita
kCal	kilocalorie
kCal/capita/day	kilocalorie per capita per day
kg	kilogram
kg/ha	kilogram per hectare
kg/year	kilogram per year
m^3	cubic meter
m^3/capita/year	cubic meter per capita per year
mm/year	millimeter per year
ton/capita	ton per capita
ton/year	ton per year

Executive Summary

"In a world of plenty, no one, not a single person, should go hungry."

– Ban Ki-moon, United Nations Secretary-General

Complexity of Food Security Challenges in the Asia and Pacific Region

Food security is achieved when "all people at all times have physical and economic access to sufficient, safe, and nutritious food" (World Food Summit 1996). Food security is a multidimensional issue. It has become increasingly complex and challenging with the impact of economic growth, changing demographics, consumption patterns, international trade, and environmental change all interconnected globally. In addition, public policy responses to these challenges can sometimes exacerbate problems. Aside from its worldwide impact, however, food security also holds immediate household and personal importance. Particularly for the poor, it defines how daily budgets are allocated. Economic growth and food security have been mutually reinforcing throughout the history of development. But that experience also illustrates that vulnerability to food insecurity cannot be fully removed by economic success alone. Strong growth has been key to the sharp decline in poverty and undernourishment, but hunger remains stubbornly high in many countries and regions. One in every eight people goes to bed hungry at night; yet there is sufficient food to feed the world. This underscores the fact that food security is much more than raising food production. It is also about reducing distortions in global food markets and ensuring equitable distribution, particularly to food-deficit countries and people.

The "two faces of Asia" make achieving food security for both Asia and the world far more complex. The economies of developing Asia and the Pacific grew an average 7.6% a year between 1990 and 2010, far exceeding the 3.4% global average. The rise in affluence in conjunction with growing populations continues to drive greater demand for more protein-rich food and better nutrition. This has enormous implications for the intensity of production. Food consumption in Asia and the Pacific has grown steadily, from 2,379 kilocalories per capita per day in 1990 to 2,665 in 2009. But some 733 million people in the region still live in absolute poverty (defined as living on less than $1.25 a day, in 2005 purchasing power parity); and 537 million remain undernourished. These are the two faces of Asia—one of progress and prosperity; the other of continued poverty. Strong income and population growth, industrialization, and urbanization continue as driving forces behind the fundamental structural change in global food production and market systems. While Asia's economic growth and ongoing structural transformation deepen the complexity in managing the limited natural resources required for food security, many pockets of Asia continue to struggle with high levels of poverty and poor nutrition.

Asia's rise adds to the pressures on land, water, and energy resources. Producing more food with fewer natural resources to meet ever-rising and evolving demand may be the ultimate challenge for the 21st century. Pressures on land, water, and energy resources are increasing. Competition over their use is intensifying. The world's population is projected to exceed 9 billion by 2050, up from today's 7 billion. Feeding 9 billion people is estimated to require about 70% more food by 2050—and almost double food production in developing countries, according to the Food and Agriculture Organization of the United Nations 2009 High-Level Expert Forum on How to Feed the World in 2050. Asia and the Pacific accounts for about 60% of the global population. By 2050, it will add about 853 million people and will command more than half of global gross domestic product (GDP). With growing incomes and more mouths to feed, the region will consume more and better food. Currently, the 60% of the global population living in the region accounts for just a little more than 50% of global food consumption—its per capita food consumption remains below the world average.

Economic growth alone does not guarantee food security. Despite spectacular economic growth, developing Asia is home to over 60% of the world's poor and hungry. Tackling undernourishment remains a challenge throughout the region. Over half a billion—or about 14%—of Asia's population are undernourished, more than all the undernourished in Africa. The severity of the food deficit for those undernourished is also above the global average—exceeded only by Africa. Over 40% of children in several Asian and Pacific countries are stunted. Focusing on nutrition—rather than simple caloric intake—is essential if food security in the region is to be achieved.

Additional challenges include changing dietary patterns and nutrition transitions in fast-growing Asian countries. Together with accelerating growth in demand, more affluent Asians demand more protein-rich and resource-demanding food—not just meat and dairy products, but also vegetables and fruits. While the growing diversity of diet is welcome, nutrition transitions also damage health; as such, obesity can now be found alongside stunting. Many countries in developing Asia and the Pacific face the double burden of fighting both under- and overnutrition.

Key Issues and Strategies for Achieving Food Security in Asia and the Pacific

This synthesis report collates the main findings from project background studies to highlight key food security issues across the region. Three major themes resonated throughout the research:

(i) **ensuring the sustainability of global food systems**, to meet growing food demand without sacrificing the resources of future generations; improving the efficiency of food production and delivery; and maximizing the benefits of international trade;

(ii) **reducing poverty and vulnerability to food insecurity**, to ensure the ability to purchase sufficient and nutritious food; reducing the price impact on real incomes of poor households; and providing effective social safety nets for those bypassed by rapid economic growth and poverty reduction efforts; and

(iii) **establishing risk management systems and tools**, to provide food-based safety nets that offer immediate relief to disadvantaged groups during crises; building adequate emergency food reserves and relief systems as a buffer to natural and human-made disasters; and introducing risk management systems and tools such as crop insurance and futures contracts to help mitigate the effects of price volatility and crises.

Trends in population, economic growth, industrialization, urbanization, and changing dietary patterns have largely encumbered already scarce natural resources. Total arable land per person in East and South Asia has been shrinking, falling from almost one-quarter hectare per person 50 years ago to an estimated one-tenth hectare by 2050. Water resources are also strained. Across Asia, between 60% and 90% of water is used for agriculture. However, share of household and industrial water consumption almost doubled during 1992–2002. The region would need an additional 2.4 billion cubic meters of water each day to provide each consumer with 1,800 calories per day by 2050. The growth in yields has been declining in Asia. And the projected impact of climate change will significantly affect soil and water resources in many subregions.

Expanding cultivated lands is no longer an option for food production growth in nearly all countries in Asia and the Pacific. Although most arable land is accounted for, there remains considerable room to increase crop yields even with currently available resources and existing technologies—provided appropriate market incentives and public support mechanisms are in place. Agricultural output and productivity can be raised in two broad ways: (i) through improved productivity at the farm level, and (ii) through better postharvest productivity. In South and Southeast Asia, about one-third of food production is lost as it travels through the supply chain.

Achieving food security hinges significantly on how inclusive growth is. Economic growth has proved effective in reducing absolute poverty. But unless its benefits are shared equitably, hunger and malnutrition will persist. Rapid growth has come with increased inequality. National and multilateral development strategies that increasingly emphasize inclusive growth must also target food security as a basic tenet.

Evidence shows that food price increases disproportionately affect the poor and negate efforts aimed at poverty reduction. The poor spend a larger proportion of their incomes—up to 70%—on food. Thus, any increase in food price slows the pace of poverty reduction. ADB (2012) estimates that, each year, from 2001 to 2010, an additional 112 million in Asia and the Pacific could have escaped poverty had food prices not increased. Volatility is another concern. In 2000–2010, food prices were not only higher than nonfood prices, they were also more volatile. A comprehensive assessment of the effects of food price inflation and volatility on population health shows that a 1 percentage point increase in contemporaneous food price inflation leads to a 0.2% increase in infant and child mortality and a 0.4% increase in prevalence of undernourishment.

With the majority of Asia's poor living in rural areas, vibrant agriculture and rural sectors are critical to successful economic transformation. Approaches to food security have to be reoriented toward rural development and agriculture as a source and central component

of ending hunger and poverty—and in promoting inclusive economic growth. As the vast majority of the poor and vulnerable in rural areas are concentrated in small-scale subsistence farming, priority must be given to improving smallholder production and productivity.

Rural development improves food security, not just through higher incomes, but also through increased productivity and thus food availability. The focus should be on more localized, smallholder, and sustainable agriculture. The production capacity of smallholders is often constrained by limited access to key inputs—such as quality seeds, fertilizer, agricultural infrastructure, and available modern technology. Enhancing small farm production and productivity requires assistance to strengthen smallholders' access to critical inputs, building and rehabilitating rural and agricultural infrastructure, improving efficiency of the food supply chain (particularly reducing postharvest losses), and expanding agricultural cooperatives.

Social safety nets play an important role in achieving food security. Social safety nets not only help provide immediate relief to disadvantaged groups during crises, but also help provide care for those bypassed by rapid economic growth and poverty reduction efforts. Food-based safety nets and related social protection programs play an essential role in building food security for the poor and vulnerable groups, given the prevailing structural weaknesses and market failures in food systems. Targeted food aid and cash transfer programs—together with other social assistance schemes—help reduce the vulnerability of poor households, help farmers manage risks, and improve community resilience.

Policy Options to Address Immediate Concerns and Improve Long-Term Resilience

Specific, urgent actions should be undertaken to address both short- and long-term issues. There is a pressing need to develop an overarching—if multilayered—policy framework covering the array of strategic directions to address immediate, short-term needs, and to prepare for medium- to long-term issues. Table A summarizes some priority actions and components to combat food insecurity and poverty, enhance the efficiency of food market systems, promote sustainable agriculture, and improve risk management and community resilience. In the short run, policies that focus on mitigating the immediate impact of high food prices on vulnerable groups, and that facilitate access to adequate, quality food through emergency measures—such as food assistance and cash transfers—will be most effective. In the longer run, scaling up agricultural productivity and investment, promoting rural development, and continuing to tackle the root causes of poverty can promote economic resilience and help build sustainable food security. At the same time, policies should be crafted to promote sustainable agricultural production and environmental protection. It is important to recognize that only planning and action now will be able to influence long-term outcomes. Delayed or inadequate decisions today will further increase vulnerability to long-term food insecurity tomorrow. International food markets and governments must be prepared to respond to supply and demand shocks as well as the effects of climate change. These are already behind today's higher food prices and volatility.

Table A: **Summary of Food Security Policies**

Actions	National	Regional/Global
Interventions to Meet Immediate Needs	• Provide emergency food assistance and enhance social safety nets • Offer programmed cash transfers • Target interventions at nutrition	• Provide timely and reliable data and information • Coordinate crisis policy responses • Facilitate flows of emergency assistance • Reduce agricultural trade restrictions and market distortions
Actions to Improve Medium- to Long-Term Resilience	• Promote agriculture and rural development • Invest in human development • Improve nutrition awareness • Consider building an emergency fund for disaster relief • Introduce insurance and disaster mitigation measures • Establish national and regional food reserves and crisis management systems	• Promote research and development, knowledge exchange, and capacity building • Improve monitoring and surveillance of food market conditions • Promote food trade liberalization • Consider mechanisms to promote price stability • Enhance collaboration on climate change and accelerate adaptation measures

Source: Authors.

Emergency food assistance and social safety nets are critical to assisting the poorest and most vulnerable, especially during temporary food crises. Sufficient, nutritious food at reasonable cost, available to all, is the capstone of political stability. Stop-gap food-based safety nets can work well in building the resilience of vulnerable populations and improving long-term food security if well targeted. Cash transfer programs limited to the poor, for instance, conditional on household participation in education, health, or nutrition services, have shown larger degrees of success. While most Asian countries use safety nets of some kind to shield poor and vulnerable groups from severe deprivation, their social protection expenditures suggest more support is needed in size and effectiveness. As a percentage of GDP, social protection expenditures amount to less than 2% in 10 of 31 Asian countries. Moreover, the effectiveness of existing schemes in developing countries hinges on their ability to accurately target the poor when needed. Errors in both exclusion (omitting households that qualify for inclusion) and inclusion (providing assistance to households that do not qualify) are high—for example, 70% for India's Public Distribution System.

Targeted nutritional interventions can significantly augment health benefits. National food security strategies have often focused on agriculture and food supply, neglecting the importance of nutrition. However, evidence is clear that food supply alone does not provide nutrition security. Undernourishment and micronutrient deficiency have a major impact on children's cognitive development and overall health. This remains a serious concern in many developing countries. Investment in health and education, and in water and sanitation infrastructure is crucial. In particular, given the strong relationship between nutritional and health knowledge and nutrition outcomes, special attention needs to be paid to nutrition education and social marketing.

Investment in infrastructure boosts productivity and reduces food losses. To lower transport costs, facilitate marketing, and ease the introduction of available technology, adequate infrastructure is essential. Transferring modern farm technology to increase land efficiency and help increase crop yields at the farm level is also an important part of the extension services.

Investing in agricultural research today is a prerequisite for tomorrow's food security. Agricultural research offers a better chance of addressing food security challenges compounded by accelerating demand, constrained natural resources, and changing climate. The challenge for the research community—and agriculture-based corporations—is to develop resilient agricultural inputs and systems using rational, affordable strategies that not only increase production, but also achieve food security for households and individuals. While research to increase agricultural productivity is essential, it must be complemented by research focusing on reducing postharvest losses, which span the entire supply chain from farm to fork.

Domestic and international trade are important elements for improving food access and availability. Trade enables food-deficit areas to secure stable long-term food supplies and helps rural communities raise productivity and income. Food value and supply chains extend beyond national borders. International trade promotes the efficient use of the world's limited resources, while trade competition induces better productivity and innovation. The revolution in food value and supply chains is a core element in the transformation required for better food security at national, regional, and global levels.

Agricultural risk management tools and policies are integral to the food security policy framework. A disaster relief emergency fund or food storage could be established as a buffer to be used in times of crisis. These can also be applied to manage crisis and disaster risk through insurance programs. Weather-based crop insurance and futures contracts add to farmers' security. Unpredictable weather limits a farmer's investment and production decisions. Crop insurance allows farmers to try more productive, if riskier, options—such as alternative crops or applying new technologies. Futures contracts, which ensure specified prices, help mitigate the risks of price volatility.

Food security requires regional and global cooperation. Regionally, three broad policies can help ensure food security and reduce excessive price volatility: adequate food stocks and reserves, accurate market information, and trade liberalization.

Emergency reserves can have important implications for social protection. Holding reserves has a limited effect on reducing food price volatility. But reserves provide a critical buffer during times of crisis for extremely vulnerable communities. Several proposals are under discussion. While international reserves run the high risk of coordination failure—and can incur considerable costs—there are several regional initiatives, especially among members of the Association of Southeast Asian Nations, to improve food reserve management and price stability. Adequate, regionally coordinated reserves could be pivotal in mitigating the effects of short-term supply shocks by allowing members to tap into regional food stocks and to reduce the storage cost at the national level.

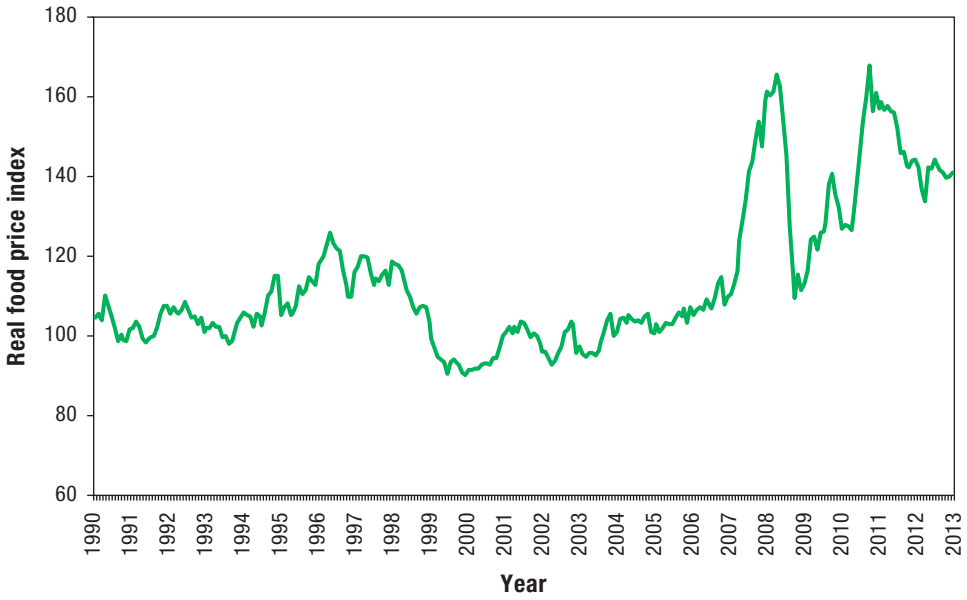
Accurate and timely information on food markets and stocks must be accessible to all. Gathered at the national level, information on markets and inventories require accurate interpretation and easy access. Generating and correctly interpreting information on stocks available are critical to preventing market speculation from spiraling out of control. Through regular dialogue, policy makers in the region can better assess market trends and help coordinate policies in response. Establishing a vibrant regional futures trade in food can also help. Aside from reducing market risk, futures trade provides a convenient platform for amassing market data and information. Similar to financial securities or other commodities, food futures would require the appropriate regulation to build and maintain market integrity.

Agricultural trade and general trade policies should promote food security through a fair and open world trading system. Historical experience shows that protectionist and unilateral measures that insulate national food stocks and prices from the world market can seriously disrupt global food market supply and price stability. Acknowledging the national political centrality of assuring adequate food, negotiating multilateral rules on reducing food export or import restrictions has proven extremely difficult. Strong regional cooperation and trust are essential for commitments to be made on banning unilateral export restrictions, reducing levels of self-sufficiency, and building emergency food reserves and aid networks in case of food crises.

I. Introduction

Food security is firmly back on the global agenda. The immediate trigger was the 2007–2008 international food crisis. The price surge was phenomenal: the overall food price index rose by 54% in the 18-month period from January 2007 to June 2008 (Figure 1.1).[1] Prices of major food crops also increased sharply—the real price of rice tripled during the period, while those of wheat and maize more than doubled (Figure 1.2). Prices again rose sharply in 2010, surpassing the 2008 peak before they moderated somewhat starting in the last quarter of 2011. Increased volatility is an added concern.

Figure 1.1: **Composite Monthly Real Food Price Index, 1990–2013**
(2002–2004 = 100)

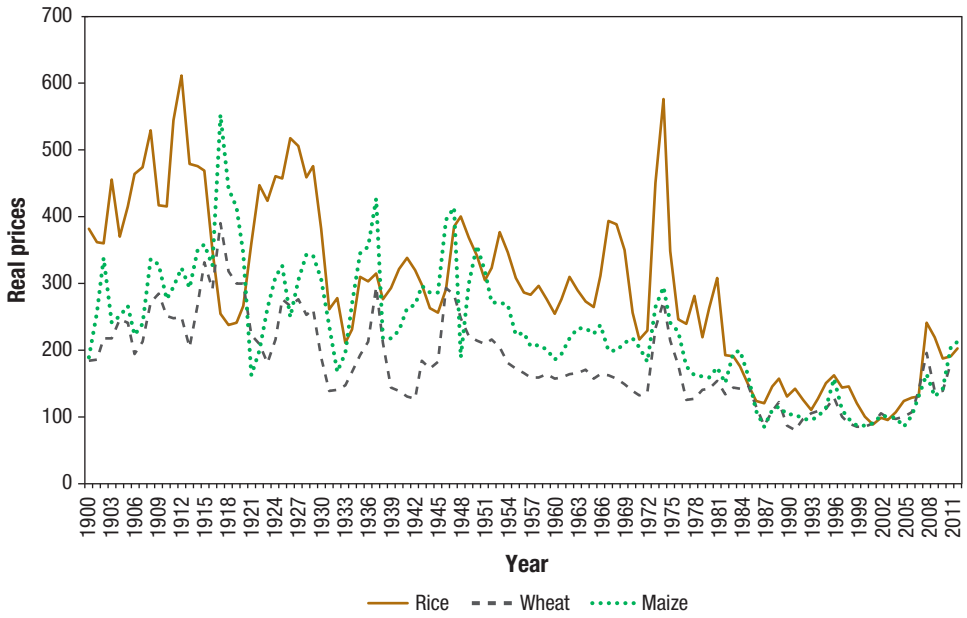


Notes:
1. The Food and Agriculture Organization of the United Nations (FAO) Food Price Index is a measure of the monthly change in international prices of a basket of food commodities. It consists of the average of five commodity group (meat, dairy, cereals, oils and fats, and sugar) price indices (representing 55 quotations), weighted with the average export shares of each of the groups for 2002–2004.
2. The composite food price index is deflated using the World Bank Manufactures Unit Value (MUV) index, a price index of internationally traded manufactured goods. Both the food price index and MUV are based to 2002–2004 prices.

Source: FAO. Food Price Index. http://www.fao.org/worldfoodsituation/wfs-home/foodpricesindex/en/ (accessed 15 April 2013).

[1] Importantly, the Food and Agriculture Organization of the United Nations (FAO) Food Price Index weights commodities by international trade share rather than global consumption. This means that highly traded commodities, like sugar, receive higher weights than thinly traded rice, even though rice is a much more important commodity in terms of consumption. This is critical in interpreting price surges. For example, the sharp 2011 increase in the food price index was the result of a surge in sugar prices—reflecting their large index weight—even if staple food prices such as those for rice were far more stable, which the index fails to show. However, the 2007–2008 spike was due to sharp price hikes across food staples.

Figure 1.2: **Real Prices of Major Cereals, 1900–2011**
(2002–2004 = 100)



Notes: Prices of all three cereals are indexed to 2002–2004. Cereal prices are deflated using the Manufactures Unit Value (MUV) index.

Sources: For data up to 2010, estimates by Grilli, E., and M. Yang. 1988. Primary Commodity Prices, Manufactured Goods Prices, and the Terms of Trade of Developing Countries: What the Long Run Shows. *The World Bank Economic Review*. 2 (1). pp. 1–47; as updated by Pfaffenzeller, S., P. Newbold, and A. Rayner. 2007. A Short Note on Updating the Grilli and Yang Commodity Price Index. *The World Bank Economic Review*. 21 (1). pp. 151–163. ADB calculations for 2011 and 2012 based on the methodology of Grilli and Yang (1988) with data on commodity prices from the World Bank Commodity Price Data (Pink Sheets) and MUV from the World Bank Development Prospects Group, http://go.worldbank.org/4ROCCIEQ50 (accessed 15 May 2013).

A confluence of factors contributed to the drastic rise in global food prices. Rapid income growth along with growing populations in developing countries has been a key driver behind increasing global demand. In addition, the rising middle class is varying its diet with higher protein intake from a wider array of sources, increasing pressure on livestock and feed industries. This growing demand highlights the reshuffled use of agricultural resources—such as land, water, and feedstock—not to mention the potential for increased damage to the environment.

On the supply side, the world must meet an escalating demand for food on less land with limited access to water. Increased costs for fertilizer and fuel for storage and transport add further pressure. Climate change and its impact on agriculture cannot be ignored. Increasingly integrated global food supply chains imply that any regional shock could easily ignite ripple effects globally.

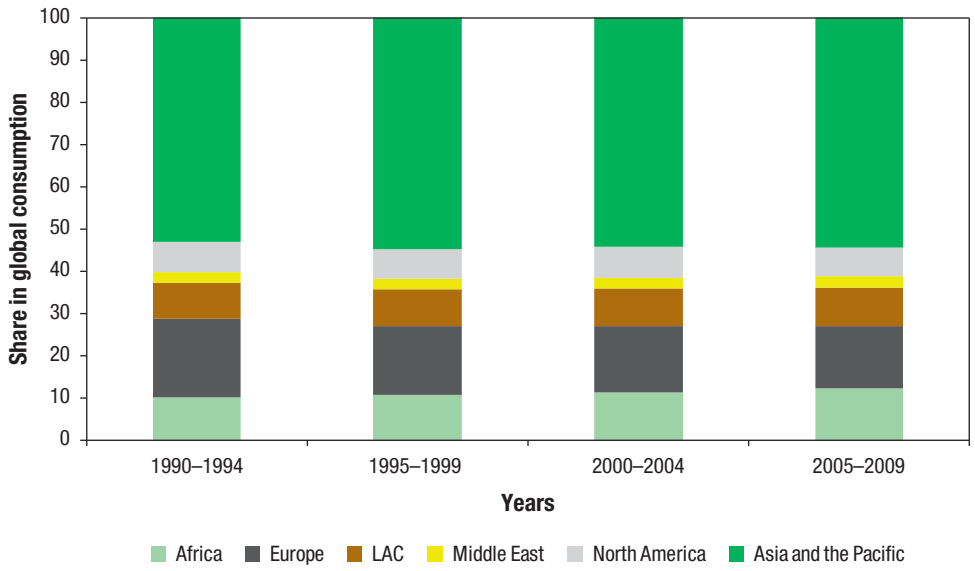
The Asia and Pacific region has been the epicenter of these global changes. Asia is continuing to experience a massive structural economic and social transformation, inevitably leaving a deeper footprint on global agricultural and ecological systems. Behind

this curtain of prosperity and progress, however, remain more than 60% of the world's poor, facing widening inequality. These "two faces of Asia" make achieving food security far more complex and challenging for both Asia and the world at large. While economic advancement and structural transformation create increasingly complex constraints on the agricultural resources needed for food security, huge areas continue to struggle against poverty and food insecurity.

Asia's share in global food consumption, measured in calories consumed, is increasing—from a 52.9% average during 1990–1994 to a 54.3% average during 2005–2009 (Figure 1.3). Consumption per capita in Asia and the Pacific went up from 2,379 kilocalories per capita per day (kCal/capita/day) in 1990 to 2,665 kCal/capita/day in 2009—an average annual increase of 0.6% compared with a 0.4% growth in global per capita consumption over the same period. Despite this rapid increase, per capita consumption in the region remains below the global average (Figure 1.4).

The region's share in global food production (crops and livestock) also increased, from an average share of 40.9% in 1990–1995 to 46.3% in 2005–2009 (Figure 1.5). Food production in Asia and the Pacific increased from 0.8 tons per capita (ton/capita) in 1990 to 1.1 ton/capita in 2009. This annual 1.7% growth was the fastest among the world's various regions—

Figure 1.3: **Share in Global Consumption by Region, 1990–2009**
(%)

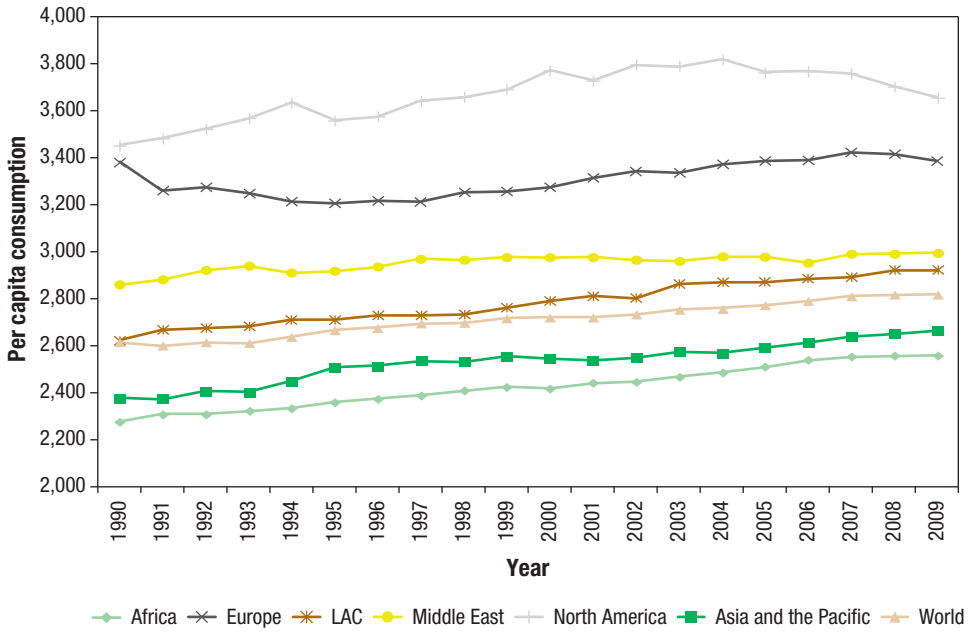


LAC = Latin America and the Caribbean.

Notes:
1. Total consumption by region was derived by multiplying each economy's consumption per capita with its population data for each year. Economy-level consumption was then aggregated up to the regional level for each year. Share in global consumption is the average share for the periods shown.
2. Refer to Appendix A for a list of economies in each region.

Sources: ADB calculations based on consumption data from the Food Balance Sheets, http://faostat.fao.org/site/368/default.aspx#ancor (accessed 10 April 2013), and population data, http://faostat.fao.org/site/550/default.aspx#ancor (accessed 7 May 2013), both from the FAO statistical database FAOSTAT.

Figure 1.4: **Consumption per Capita by Region, 1990–2009**
(kCal/capita/day)



kCal = kilocalorie, LAC = Latin America and the Caribbean.

Notes:
1. Consumption per capita by region was derived by aggregating consumption in all economies in each region and then dividing it by the region's total population. Estimation of aggregate regional consumption is explained in notes to Figure 1.3.
2. Refer to Appendix A for a list of economies in each region.

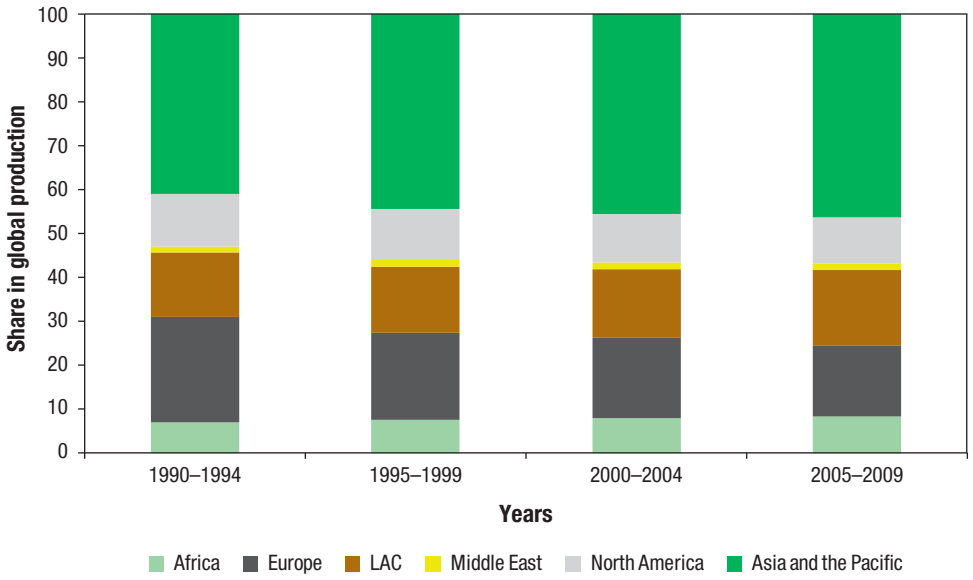
Sources: ADB calculations based on consumption data from the Food Balance Sheets, http://faostat.fao.org/site/368/default.aspx#ancor (accessed 10 April 2013), and population data, http://faostat.fao.org/site/550/default.aspx#ancor (accessed 7 May 2013), both from FAOSTAT.

more than double the world average growth of 0.8% during the same period. Nonetheless, production per capita in Asia and the Pacific remains below the global average (Figure 1.6).

Price surges and concern over global food security carry a sense of déjà vu. Global attention emerged during the mid-1970s global food price crisis. While the initial focus was on food supply, the meaning of "food security" has broadened over time to include adequate nutrition and sufficient "food access" by the most vulnerable—to balance the demand side of the equation.

However, urgency lost its impetus as real food prices steadily declined from their mid-1970s peak until they hit an all-time low in the early 2000s (Figures 1.1, 1.2). Declining prices brought complacency and led to decades of neglect in agricultural and rural development, allowing demand pressures to catch up. The probable causes of the crisis of the latter part of the first decade of the 2000s resemble those of the mid-1970s crisis. Both derived from high oil prices, low food stocks, dollar devaluation, demand shocks—the use of biofuels in the late 2000s against large United States (US) cereal exports to the former Soviet bloc in the

Figure 1.5: **Share in Global Production by Region, 1990–2009**
(%)



LAC = Latin America and the Caribbean.

Notes:
1. Production by region was derived by aggregating production in all economies in each region for each year. Economy-level food production data was computed by adding the total of primary crop production and primary livestock production, with all commodity production data measured in tons. Share in global production is the average share for the periods shown.
2. Refer to Appendix A for a list of economies in each region.

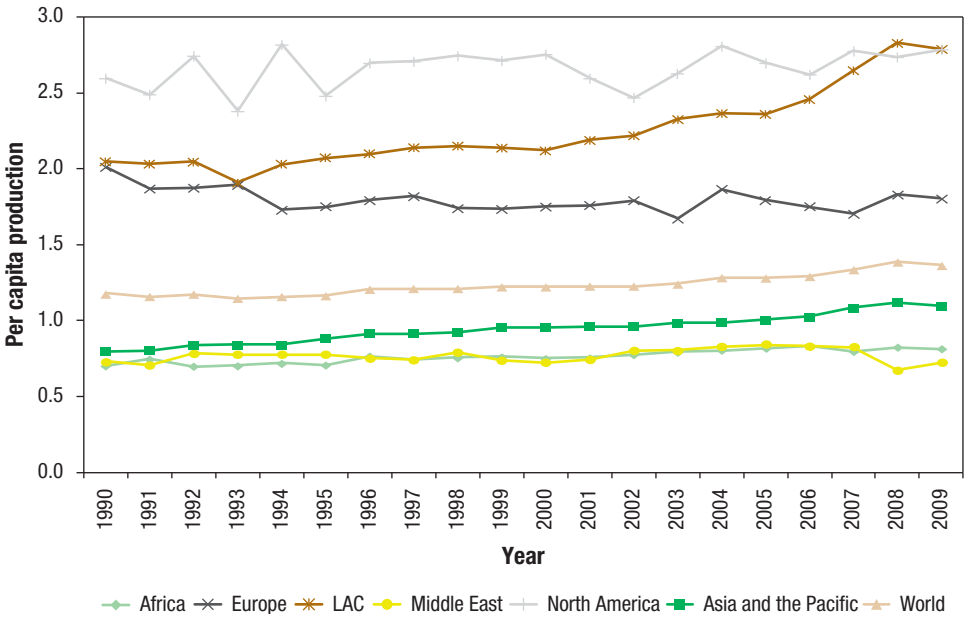
Sources: ADB calculations based on primary crop production data, http://faostat.fao.org/site/567/default.aspx#ancor (accessed 18 June 2013), and primary livestock production data, http://faostat.fao.org/site/569/default.aspx#ancor (accessed 18 June 2013); and population data, http://faostat.fao.org/site/550/default.aspx#ancor (accessed 7 May 2013), all from FAOSTAT.

1970s—and weather-related supply shocks. These similarities underscore the unfinished reform agenda, despite international efforts to tackle underlying structural problems in the global food system.

The issue of food security remains an integral part of the international development policy discourse. Poverty and food insecurity remain closely interrelated. Poor food and nutrition critically damage people's health, retard human development, and lower labor productivity over the long term. About 868 million people worldwide are chronically undernourished, with nearly all (97.5%) in developing countries. Scientific research shows that poor nutrition weakens the immune system, increasing disease incidence and severity (for example, Chandra 1991, 1997; Tomkins and Watson 1989). Malnutrition and undernourishment also damage physical and cognitive development, especially among children—leading to chronic health problems later, and impeding work and productivity.

With the 2015 target for attaining the Millennium Development Goals (MDGs) fast approaching, those relating to hunger and nutrition have not been met in many parts of

Figure 1.6: **Production per Capita by Region, 1990–2009**
(ton/capita)



LAC = Latin America and the Caribbean.

Notes:
1. Production per capita by region was derived by aggregating production by region and then dividing the estimates by their respective aggregate population figures. Estimation of regional production is explained in notes to Figure 1.5.
2. Refer to Appendix A for a list of economies in each region.

Sources: ADB calculations based on data on primary crops production, http://faostat.fao.org/site/567/default.aspx#ancor (accessed 18 June 2013), and primary livestock production, http://faostat.fao.org/site/569/default.aspx#ancor (accessed 18 June 2013); and population data, http://faostat.fao.org/site/550/default.aspx#ancor (accessed 7 May 2013), all from FAOSTAT.

Asia and the Pacific. At the 2012 "Rio+20" United Nations (UN) Conference on Sustainable Development, world leaders agreed to carry forward the spirit of the Millennium Declaration by setting new goals and targets to keep the momentum. Continuing discussions on post-2015 MDGs are leading to a revised development agenda, with a goal to end extreme poverty and work toward sustainable development. Food and nutrition security remain central—the High-Level Panel of Eminent Persons on the Post-2015 Development Agenda made ensuring food security and good nutrition the fifth in 12 illustrative goals for achieving the new vision for a better planet and a world free from extreme poverty by 2030 (UN 2013).

But obtaining food security within the context of inclusive growth and poverty reduction is a daunting challenge for Asia and the Pacific. The region's economic growth has been impressive, dramatically transforming economic, social, and environmental systems. Absolute poverty may have been cut by more than half due to stellar growth, but the benefits of this growth have not been shared equitably. How poverty and food insecurity are tackled will be a crucial gauge of the region's ability to achieve sustainable and inclusive economic growth with social cohesion. As the region's socioeconomic influence grows globally, decisions taken will have considerable worldwide implications for socioeconomic stability

and environmental sustainability—fundamental prerequisites for achieving food security. How the region enmeshes economic growth, structural transformation, and demographic transition will be a critical determinant for successfully building food security—not just for the region, but for the world.

In 2012, the Asian Development Bank (ADB), in collaboration with Foreign Affairs, Trade and Development Canada (DFATD); the Asia-Pacific Economic Cooperation (APEC); and the Liu Institute for Global Issues at the University of British Columbia (UBC), set out to further understand, synthesize, and articulate key policy challenges and opportunities related to food security in Asia and the Pacific. A multidisciplinary approach was used to conduct comprehensive research on the various economic, social, and environmental aspects of food security. While analyzing the dynamics of food markets globally, regionally, and nationally, the study focused on the issues particularly relevant to Asia and the Pacific. Given the region's size and diversity, some issues were examined in aggregate, while others were studied at the subregional or national level.

This synthesis report, while collating the findings of the various studies, highlights major themes that resonated throughout the research—demand and supply considerations, the effects of climate change, sustainable agriculture, and policy options for attaining food security. In sum, there are three main ways to enhance food security:

(i) ensuring the sustainability of global food systems, to meet growing food demand without sacrificing the resources of future generations; improving production and delivery efficiency; and maximizing the benefits of international trade;

(ii) reducing poverty and people's vulnerability to food insecurity, to ensure the ability to purchase sufficient and nutritious food; reducing the price impact on real incomes of poor households; and providing effective social safety nets for those bypassed by rapid economic growth and poverty reduction efforts; and

(iii) establishing risk management systems and tools, to provide food-based safety nets that offer immediate relief to disadvantaged groups during crises; building adequate emergency food reserves and relief systems as a buffer to natural and human-made disasters; and introducing risk management systems and tools such as crop insurance and futures contracts to help mitigate the effects of price volatility and crises.

The remainder of the report is organized as follows. In the context of the region's rapid structural transformation, Section II discusses the definition of food security and what it means for Asia and the Pacific. Section III reviews household access to food, focusing on the relationship between food security and poverty reduction, the importance of nutrition in changing dietary patterns, the impact of food crises on poverty and health, and the role of social safety nets. Section IV examines food availability, analyzing structural problems in food production systems rooted in constraints on agricultural resources, productivity, and research. Section V discusses the challenges of getting food "from farm to fork"—through efficient transportation, logistics, and international trade. Section VI assesses the effects of climate change. Section VII offers a policy framework for enhancing food security in the region. A summary and conclusion follow in Section VIII.

II. Food Security: What It Means for Asia and the Pacific

Food is different from other usual commodities in that there is no substitute. All humans require adequate food for survival. Security over the next meal is essential. The 1996 World Food Summit defined food security as existing "when all people at all times have access to sufficient, safe, nutritious food to maintain a healthy and active life."[2] Food security, according to the World Health Organization (WHO), rests on three pillars:[3]

(i) Food availability covers the supply side. Is there enough to feed people? Food availability is determined by food production and technology, inventory, efficiency of supply chains, and local and international trade.

(ii) Food access is the ability to obtain adequate quantities of food, the purchasing power needed, and adequate delivery mechanisms, including social safety nets; and

(iii) Food utilization refers to the need to meet dietary needs and cultural preferences.

Food security also means certainty about future meals. Not knowing where the next meal will come from alters economic behavior. Providing for future meals takes precedence over other expenditures, such as education, health, and shelter. Beyond household concerns, food price inflation can trigger the demand for wage increases, igniting a vicious inflationary cycle that could discourage private investment and slow economic activity in general. This reduces investment in human and physical capital, and can damage a country's long-run growth prospects.

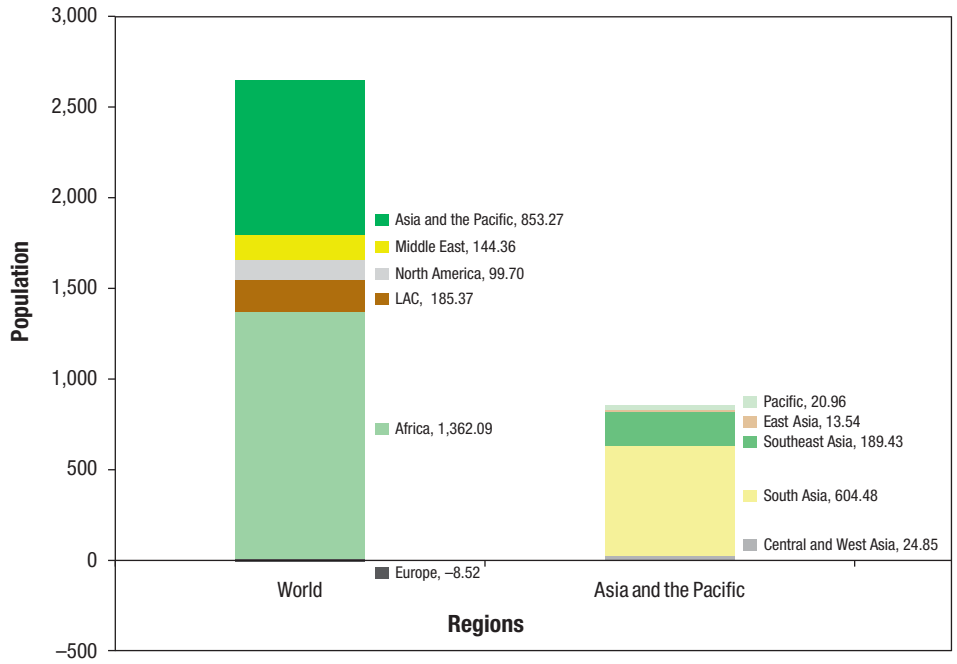
In Asia and the Pacific, food security is being fundamentally altered—as patterns of food consumption and production change with the drive for global food sustainability. These forces stem from the region's huge population, changing demographics, and spectacular economic rise. The dramatic structural transformation economically, socially, and culturally holds important consequences for the global food system.

Asia's Growing Population and Economic Size

Already home to 56% of the global population, Asia and the Pacific will account for one-third of the projected 2.6-billion increase in global population between 2010 and 2050 (Figure 2.1). Of this 853 million increase in Asia and the Pacific, 71% will be in South Asia. In economic terms, developing Asia and the Pacific[4] is also the world's fastest-growing

2 See http://www.fao.org/docrep/003/w3613e/w3613e00.HTM for the Rome Declaration on World Food Security.
3 See http://www.who.int/trade/glossary/story028/en/
4 Developing Asia and the Pacific refers to economies listed in Appendix A excluding Australia, Japan, New Zealand, and Singapore.

Figure 2.1: **Estimated Change in Population between 2010 and 2050 (millions)**



LAC = Latin America and the Caribbean.

Note: Refer to Appendix A for a list of economies in each region.

Source: ADB calculations based on economy-level estimates of the projected population (based on the assumption of medium-fertility variant) from the United Nations (UN) Department of Economic and Social Affairs, Population Division. 2013. *World Population Prospects: The 2012 Revision*. http://esa.un.org/wpp/Excel-Data/population.htm (accessed 15 June 2013).

region—with real GDP expanding at an annual average of 7.6% during 1990–2010, far exceeding the 3.4% global average. Using a baseline scenario of continued growth trends, an ADB study (2011) suggests developing Asia will account for more than half of global GDP by 2050.[5] More than 60% of cereal demand in the developing world will come from South and East Asia by 2030, with cereal demand expected to increase 1.6% annually in South Asia and 1.2% in East Asia from 1999 to 2030 (ADB 2009b).

The rise of Asia's two giant economies—the People's Republic of China (PRC) and India—could dramatically alter global and regional food systems. The PRC and India together account for 37% of the world's population, but available arable land and water supplies are limited relative to the number of people. While food demand is fast increasing with rising incomes and population, ensuring sufficient supply presents potentially huge challenges. Aside from evolving national systems, the scale and pace of change in socioeconomic development in the PRC and India will impact global and regional food systems as well.

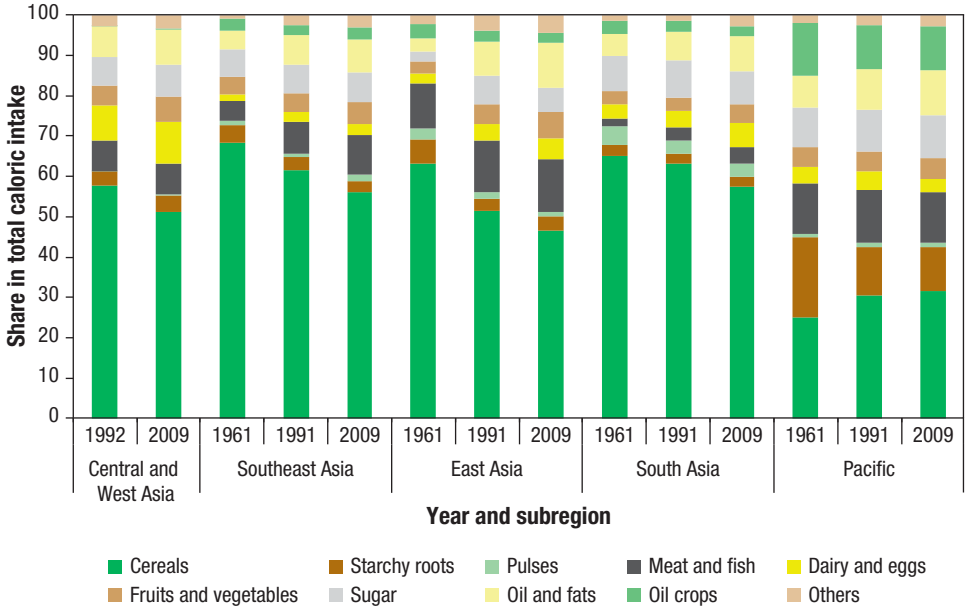
5 According to one estimate (ADB 2011), average per capita income in the People's Republic of China (PRC), India, Indonesia, Japan, the Republic of Korea, Malaysia, and Thailand is projected to top $45,800 (purchasing power parity [PPP]) by 2050.

Urbanization and Dietary Change

Asia's urban population share almost doubled from 24.6% in 1970 to 46.5% in 2010—and it is expected to reach 70% by 2050 (UN 2012).[6] Urbanization influences dietary patterns through the sociocultural environment and lifestyle, while eroding agricultural and land resources used for cultivation. The net effect of this on the global food system is complex, with varying impacts on food demand and supply. These are important structural transformations and are affecting global food market dynamics and price movements.

Asia's growing middle class has diversified its diet away from staple cereals toward meat, dairy products, fruits, and vegetables (Figure 2.2). Rapid urbanization and the rise of megacities are fuelling this trend. This has led to a significant decline in the share of cereals in total caloric intake. Higher-value items such as processed foods, meat and dairy products, and tropical beverages are increasingly popular. Projections show most of the increase in animal protein demand by 2030 and beyond will likely come from developing Asia. For example, between 2000 and 2030, the annual consumption of beef is expected to increase by 25.4 million tons, of which almost half (12.2 million tons) will be from Asia (FAO 2011). In the case of poultry, annual consumption in 2030 is expected to increase by 60.3 million tons relative to 2000 levels, more than half (34.0 million tons) of which will come from Asia.

Figure 2.2: **Changing Dietary Composition in Asia and the Pacific, 1961–2009** (%)



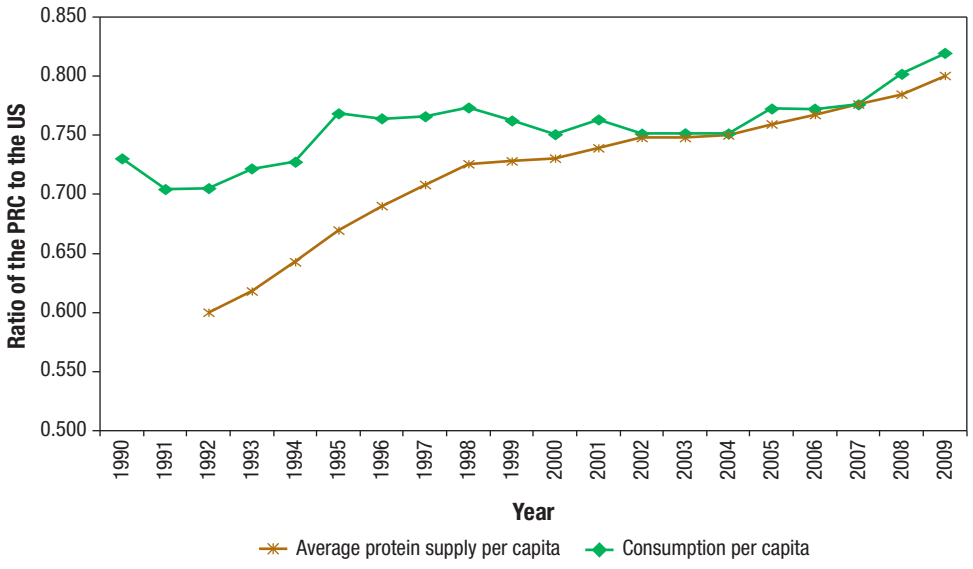
Note: Refer to Appendix A for a list of economies in each region.

Source: ADB estimates based on the Food Balance Sheets, FAOSTAT. http://faostat.fao.org/site/368/default.aspx#ancor (accessed 10 April 2013).

6 This estimate is based on economies in Central and West Asia, East Asia, South Asia, and Southeast Asia as listed in Appendix A.

Changing dietary patterns in the PRC are significantly influencing global food markets and prices. Incomes and demographic trends have already led to an increase in meat, dairy, and fish consumption as well as boosted general caloric intake (Figure 2.3). While the PRC has achieved remarkable growth in agricultural production—as annual per capita agricultural output growth averaged over 3.8% from 1978 to 2011 (Organisation for Economic Co-operation and Development [OECD]-FAO 2013)—rapid demand growth has turned the PRC into one of the world's leading importers of a wide range of agricultural products, particularly oilseeds; its market share was estimated at 54% of the global total for 2011–2012. The country's appetite for meat, especially pork, is also potentially changing global meat and feed balances fundamentally. In the last 30 years, meat consumption has increased by more than 5 times in the PRC and now reaches more than 70 million tons per year (ton/year)—or a quarter of world supply (Larsen 2012). Higher meat consumption also implies higher demand for feed. Evidence shows the recent price surge in soybeans may derive from growing demand in the PRC, not solely for direct consumption (as in soybean products and vegetable oils), but for indirect consumption as well (feed for livestock). This increased demand for livestock and feedstock adds stress to food production systems and impacts the environment.

Figure 2.3: **Average Protein Supply per Capita and Consumption per Capita of the PRC Relative to the US, 1990–2009**



PRC = People's Republic of China, US = United States.

Notes:
1. Data on the average protein supply per capita are 3-year averages. Data for 1992 is the average for 1990–1992 and so on.
2. Consumption per capita estimates are expressed in kilocalorie/capita/day (kCal/capita/day).
3. Ratios are computed by dividing the PRC figures by those for the US.

Source: ADB calculations based on estimates from Food Security Indicators, http://www.fao.org/economic/ess/ess-fs/ess-fadata/en/ (accessed 23 April 2013), and data from Food Balance Sheets, http://faostat.fao.org/site/368/default.aspx#ancor (accessed 10 April 2013), both from FAOSTAT.

Structural Transformation and Sustainable Agriculture

Asia's stellar economic growth brought with it a fundamental structural transformation, characterized by a drop in agricultural share of GDP and employment. This continuing structural transformation creates increasingly complex constraints on the availability and sustainability of natural resources needed to achieve food security. The only sensible solution is to enhance agricultural productivity through higher yields, using scarce natural resources better, and increasing the efficiency of product use—for example, improving the efficiency of product delivery and minimizing waste. Meeting future demand for food without compromising the needs and resources of future generations is paramount. The forces of rapid industrialization and urbanization, and the region's structural transformation generally compound this challenge. Growing competition and the overexploitation of natural resources increasingly constrict the region's ability to produce food.[7] The increased use of petroleum products has secondary effects on food prices through increased costs of energy and fertilizers, while some agricultural production has been diverted toward biofuel production.

Climate Change

Climate change will impact the availability of agricultural resources and the sustainability of food security. Many countries in the region are vulnerable to climate change—as seen through severe floods and droughts in recent years. Rising temperatures could reduce crop productivity in tropical regions. One study (Piao et al. 2010) estimates that the yield potential in the PRC for major crops—rice, wheat, and maize—could fall from the 2000 baseline by 15% to 25% by 2050. Yields are expected to decline in tropical regions such as South and Southeast Asia through at least 2100. According to one estimate, relative to 1990, rice yields in Southeast Asia are projected to fall some 50% by 2100 (ADB 2009c). Climate change could impact food production in other ways, including changes in rainfall patterns and warming surface waters—oceans, rivers, and lakes—already pressuring fisheries. Despite the uncertainty over its full impact on food productivity, it is clear climate change poses a serious risk to future food security.

Finally, when considering food security in Asia and the Pacific, the special role of rice cannot be understated. Rice is the staple food for much of Asia and the Pacific, providing a large portion of daily caloric intake (Table 2). Historically, rice price stability was crucial for urban wage earners during rapid economic growth and industrialization in many Asian economies (Timmer 2012b). Its economic and political importance is indisputable, reflected largely in heavy government market intervention and proclaimed self-sufficiency across Asia's rice-consuming countries. But with the global rice market relatively thin compared with other crops, rice price volatility is far more pronounced than for most other staple foods. Although the share of rice in caloric intake is falling rapidly, rice remains a major food item for the poor, who spend disproportionately more of their household budgets on rice compared with the nonpoor (Timmer 2012b). This helps explain why Asian countries were so greatly alarmed by the huge price increases in rice during the 2007–2008 food crisis.

[7] See Kandlikar and Ramankutty (2012) for a discussion on the implications of the competing demand for land use.

Table 2: **Rice Consumption, Caloric Intake, and Percentage of Calories from Rice, 1990–1992 and 2007–2009**

Region	1990–1992			2007–2009		
	Average Rice Consumption (kCal/capita/day)	Average Total Food Consumption (kCal/capita/day)	Average Share of Rice in Total Food Consumption (%)	Average Rice Consumption (kCal/capita/day)	Average Total Food Consumption (kCal/capita/day)	Average Share of Rice in Total Food Consumption (%)
Southeast Asia	1,176	2,177	54.0	1,255	2,626	47.8
South Asia	772	2,234	34.6	736	2,340	31.4
East Asia	797	2,568	31.0	775	2,955	26.2
World	532	2,613	20.4	537	2,816	19.1
LAC	255	2,656	9.6	262	2,913	9.0
Africa	170	2,299	7.4	209	2,556	8.2
Middle East	260	2,888	9.0	244	2,992	8.1
Pacific	97	3,043	3.2	142	3,143	4.5
North America	73	3,487	2.1	89	3,707	2.4
Central and West Asia	97	2,606	3.7	59	2,787	2.1
Europe	44	3,307	1.3	54	3,400	1.6

kCal = kilocalorie, LAC = Latin America and the Caribbean.

Notes:
1. Regions are arranged in the descending order of share of calories derived from rice averaged for 2007–2009.
2. Regional estimates of total consumption and rice consumption are weighted averages of economies in that region with weights being population share of economies in that region.
3. Average shares are obtained by averaging annual shares for 1990–1992 and 2007–2009.
4. For Central and West Asia, estimates for 1990–1992 make use of data for 1992 only as data are not available prior to that.
5. Refer to Appendix A for a list of economies in each region.

Sources: ADB estimates based on consumption data from the Food Balance Sheets, http://faostat.fao.org/site/368/default.aspx#ancor (accessed 10 April 2013); and population data, http://faostat.fao.org/site/550/default.aspx#ancor (accessed 7 May 2013), both from FAOSTAT.

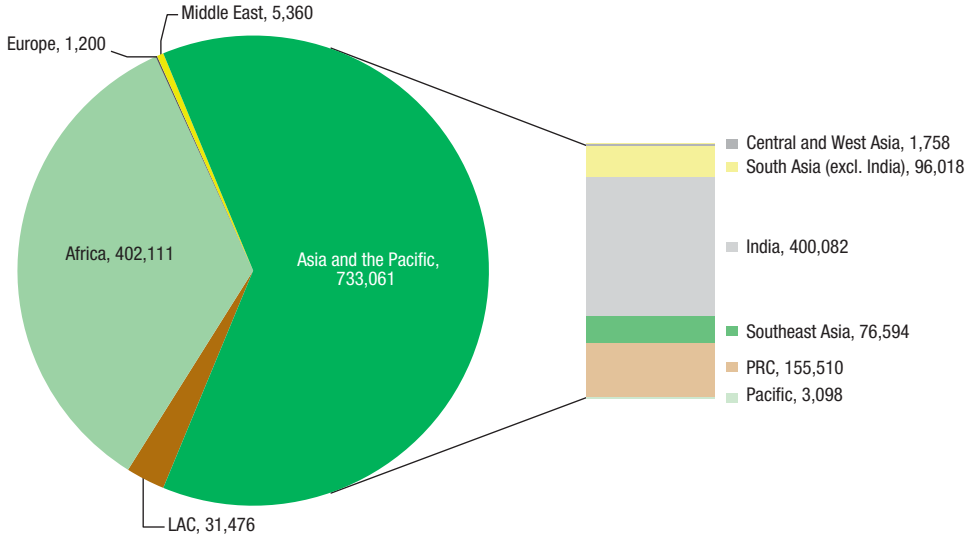
III. Access to Food: Poverty, Nutrition, and the Impact of Food Crises

For most people, access to food is a matter of purchasing power. The rich are never in want, except in extreme circumstances of war or natural disasters. And obviously, even then, the poor are affected far more severely. Thus, higher per capita income resulting from economic growth brings with it food security.

Poverty and Undernourishment in Asia and the Pacific

Throughout Asia and the Pacific, poverty remains the most daunting challenge. Despite spectacular economic growth, developing Asia is home to more than 60% of the world's 1.2 billion people living on less than $1.25 a day (2005 purchasing power parity [PPP]; Figure 3.1). Two-thirds of the region's poor (or about 42.6% of the world total) are

Figure 3.1: **The World's Poor, 2010 Estimates ('000)**



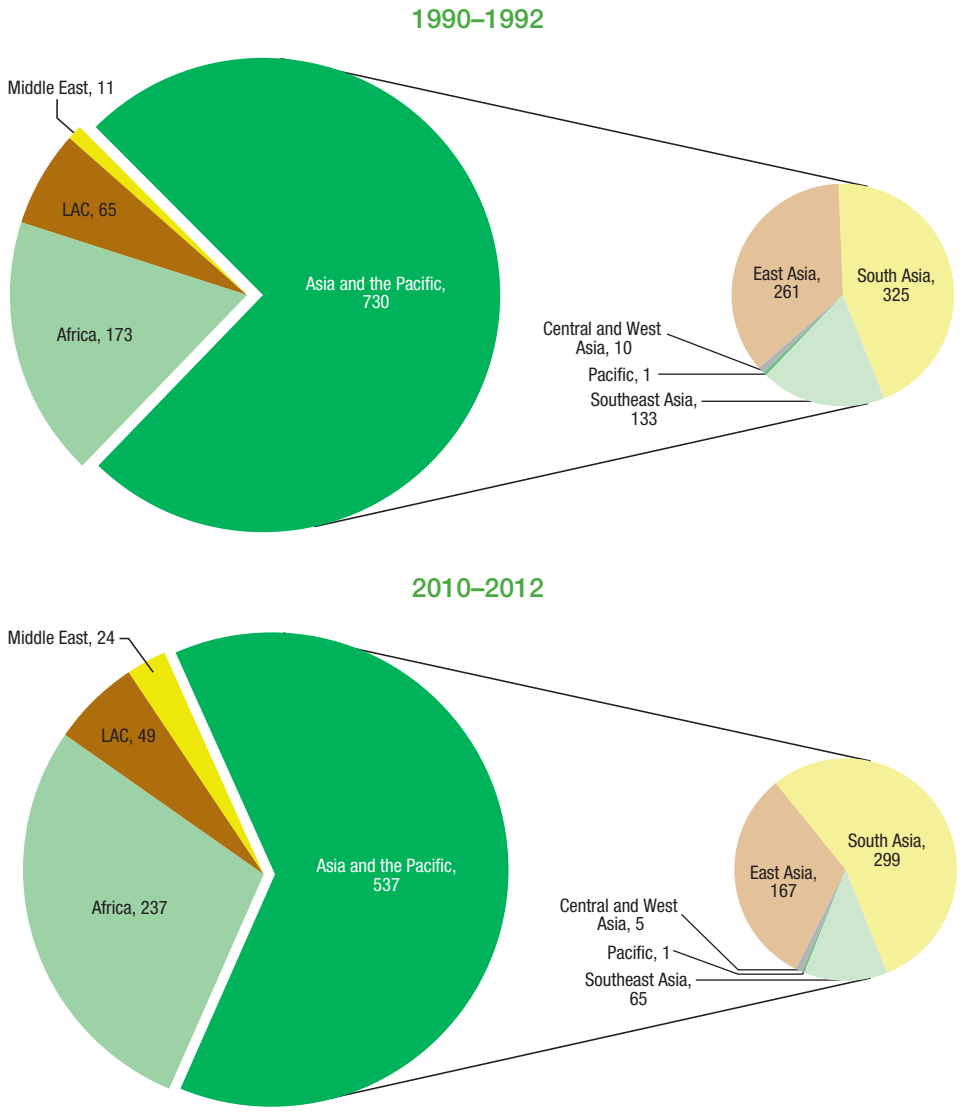
PRC = People's Republic of China, excl. = excluding, LAC = Latin America and the Caribbean.

Notes:
1. The poor are those living on less than $1.25 a day (2005 purchasing power parity [PPP]).
2. Refer to Appendix A for a list of economies in each region.

Source: ADB calculations based on economy-level estimates from PovcalNet (a web-based tool for poverty measurement developed by the Development Research Group of the World Bank), http://iresearch.worldbank.org/PovcalNet/index.htm?1 (accessed 23 April 2013).

concentrated in South Asia. The region has 537 million undernourished people, about 62% of the global total (Figures 3.2). Within Asia and the Pacific, regional disparities are large. Of Asia's malnourished, 299 million are in South Asia alone, more than the 237 million in Africa. The number of malnourished children is particularly alarming. Childhood stunting exceeds

Figure 3.2: **The World's Undernourished**
(millions)



LAC = Latin America and the Caribbean.

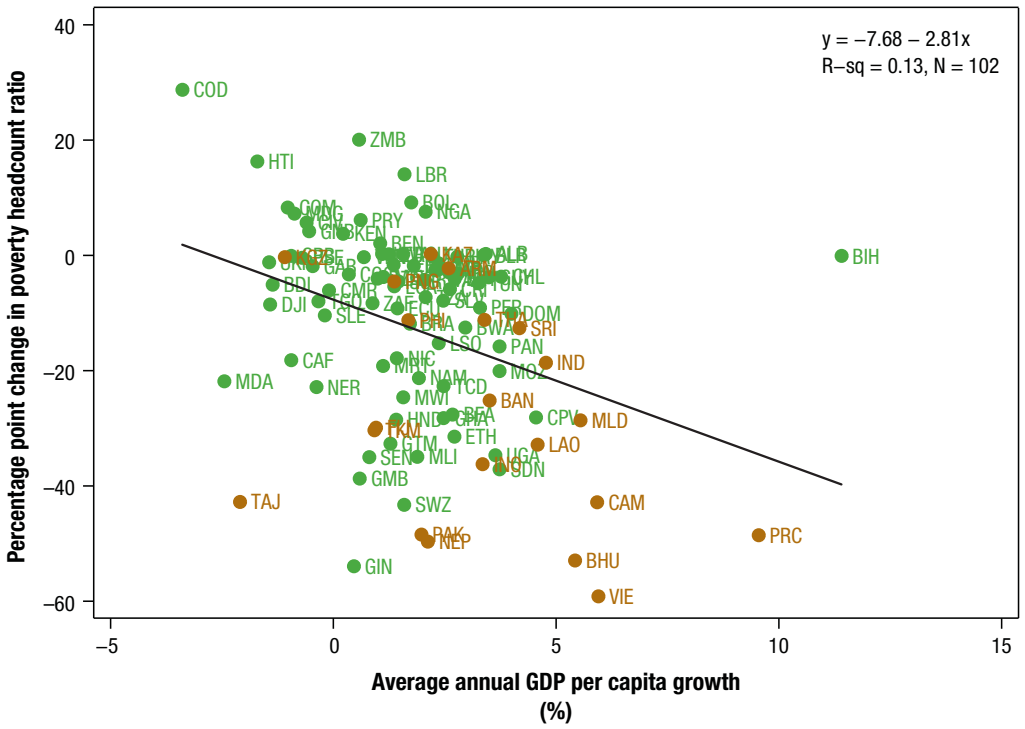
Notes:
1. The undernourished are those with a caloric intake less than the minimum daily requirement. Averages for 1990–1992 and 2010–2012 are shown.
2. Refer to Appendix A for a list of economies in each region.

Source: ADB calculations based on economy-level estimates from the FAO Food Security Indicators, http://www.fao.org/economic/ess/ess-fs/ess-fadata/en/ (accessed 23 April 2013).

40% in several Asian and Pacific island economies. This proportion is comparable with Sub-Saharan Africa, but larger in absolute numbers.

Food insecurity and poverty go hand in hand. Higher per capita income growth brings more poverty reduction (Figure 3.3). Sustained poverty reduction increases household capacity to purchase essential commodities, including food. Thus, sustained poverty reduction enhances long-term food security. Economic growth also improves food security through greater spending on infrastructure, improving delivery. The higher government revenue that accompanies economic growth can also be used to provide social safety nets, including those targeting food deficits.

Figure 3.3: **Growth and Change in Poverty in Low- and Middle-Income Economies, 1990–2010**



GDP = gross domestic product, N = sample size, R-sq = R-squared.

Notes:

1. GDP per capita is based on GDP measured in constant 2005 PPP$.
2. Poverty headcount ratio is the proportion of the population living on less than $1.25 a day (2005 PPP), and is expressed in percent.
3. Percentage point change in poverty headcount ratio is computed as the difference of the values between 2010 and1990.
4. The line shown is obtained from the linear regression of the percentage point change in poverty headcount ratio (y) during 1990–2010 on the average GDP per capita growth (x) during 1990–2010. The regression results are embedded in the chart. The coefficient on average GDP per capita growth is statistically significant at the 5% level of significance.
5. Economies in Asia and the Pacific are shown in brown.
6. Refer to Appendix B for a list of three-character economy codes.

Sources: ADB calculations based on GDP data from the World Bank World Development Indicators (WDI), http://data.worldbank.org/data-catalog/world-development-indicators (accessed 22 April 2013); and poverty estimates from PovcalNet, http://iresearch.worldbank.org/PovcalNet/index.htm?1 (accessed 23 April 2013).

One could argue a two-way relationship between long-term sustained growth and food security. Those well nourished are likely to be healthier and less prone to illness, and therefore contribute to higher productivity and economic growth. Food insecurity can impede household investment in education and health, disrupting human capital formation and undermining long-term growth prospects. Food insecurity itself can create instability in households, communities, and nations—further impeding growth and development.

Food insecurity and poverty incidence, however, differ in several important aspects. First, poverty incidence relates to the consumption of a wide range of goods, of which food is only one, though the most important. Poverty line studies (which determine the per capita expenditure level below which one is deemed poor) particularly focus on the expenditure level that coincides with an adequate diet.

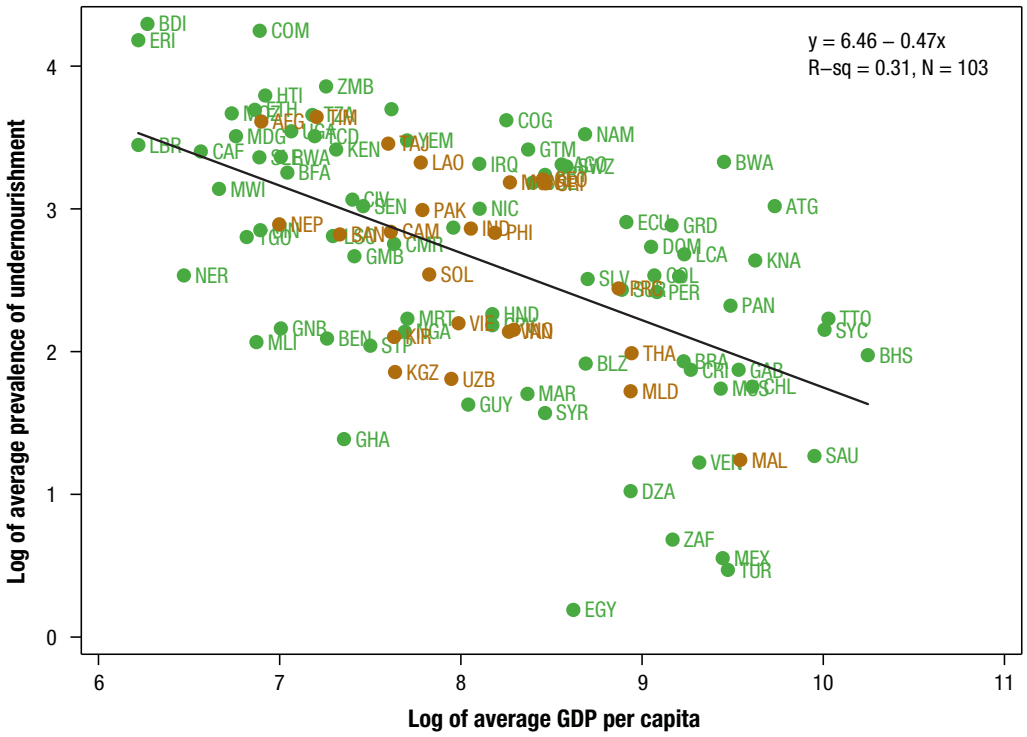
A second, more basic difference is that poverty incidence refers to current circumstances, not expectations. At the time a household is surveyed, consumption levels of food and other goods either are or are not adequate. If they are not, the household is deemed poor. But food security refers more to expectations than today's circumstances. Individuals or households may judge themselves food insecure even if their present food consumption is sufficient. "Vulnerability to poverty" is conceptually closer to food insecurity than "poverty incidence." And while vulnerability to poverty is statistical, based on circumstances observable in the present, food security inherently involves perceptions—expectations about the future.

Differences between the concepts of food insecurity and poverty incidence notwithstanding, food insecurity is closely related with income and poverty. Poor people are the most likely to be hungry, and a reduction in the prevalence and depth of poverty will likely improve food security indicators. Evidence shows an inverse relationship between various measures of food insecurity (prevalence of undernourishment, depth of food deficit, and prevalence of food inadequacy) and per capita income (Figures 3.4a, 3.4b, 3.4c).

Various indicators of food security show impressive progress, but undernourishment remains a serious problem (Table 3.1). What is striking is the difference in the rate at which undernourishment has declined in different parts of the world. Between 1990–1992 and 2010–2012, the number of undernourished in Asia (Figure 3.2) was reduced by 26.5%—from 730 million in 1990–1992 to 537 million in 2010–2012—far exceeding the global decline of 13.2% (from 1 billion in 1990–1992 to 868 million in 2010–2012). In Africa, the number of undernourished increased 37% over the same period. Results also varied widely within Asia. In Southeast Asia, the absolute number of undernourished people declined by more than 50%, with East Asia not far behind at 36%. But in South Asia the decline—8%—was much lower. Differences in poverty reduction could be one of the reasons. Economies which show a greater reduction in poverty incidence also show a greater decline in prevalence of undernourishment (Figure 3.5). Improved economic access to food combined with rapid growth and poverty reduction was key to the decline in undernourishment.

While the share of undernourished in the population reflects the prevalence of poverty, it does not say anything about the extent of undernourishment—which is defined as the difference between actual intake and minimum daily caloric requirement among those undernourished. This is referred to as the "depth" of the food deficit and is measured

Figure 3.4a: **Prevalence of Undernourishment and Income, 2010–2012**



GDP = gross domestic product, N = sample size, R-sq = R-squared.

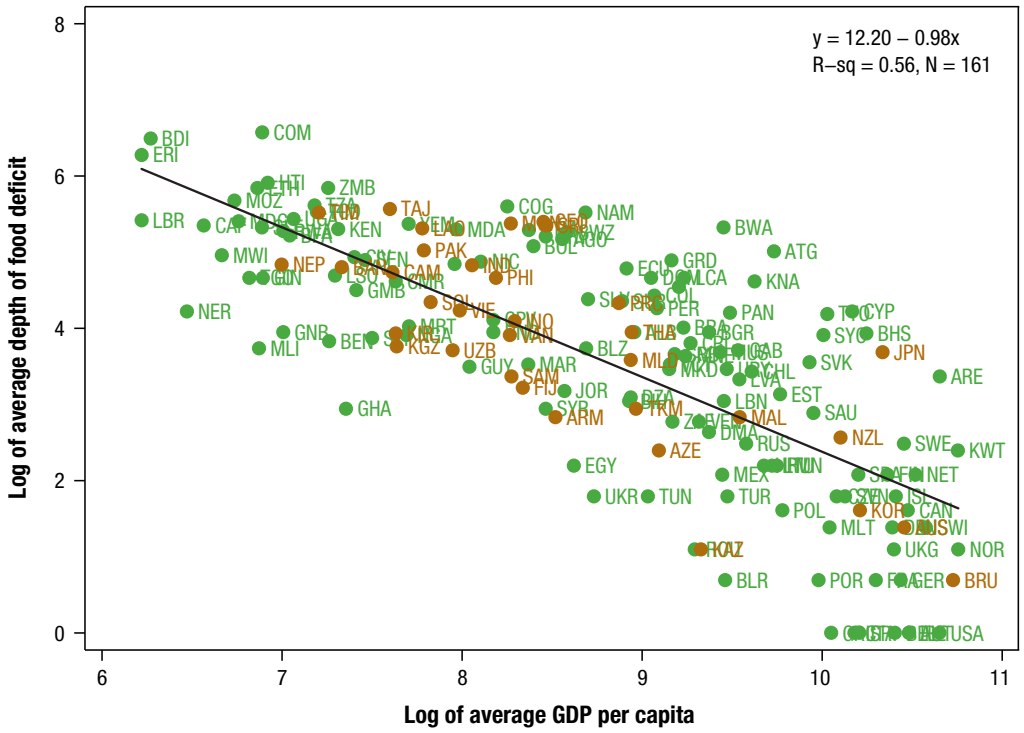
Notes:

1. GDP per capita is based on GDP measured in constant 2005 PPP$. Average GDP per capita for 2010–2012 is shown.
2. Prevalence of undernourishment is defined as the proportion of the population with a caloric intake less than the minimum daily requirement and is expressed in percent. Average prevalence of undernourishment for 2010–2012 is shown.
3. The line shown is obtained from the linear regression of the log of prevalence of undernourishment (y) averaged for 2010–2012 on the log of GDP per capita (x) averaged for 2010–2012. The regression results are embedded in the chart. The coefficient on log of average GDP per capita is statistically significant at the 1% level of significance.
4. Economies in Asia and the Pacific are shown in brown.
5. Refer to Appendix B for a list of three-character economy codes.

Sources: ADB estimates based on undernourishment data from the FAO Food Security Indicators, http://www.fao.org/economic/ess/ess-fs/ess-fadata/en/ (accessed 23 April 2013); and GDP data from the World Bank WDI, http://data.worldbank.org/data-catalog/world-development-indicators accessed (22 April 2013).

in kCal/capita/day. Along with the reduction in the prevalence of undernourishment, the depth of the food deficit has also fallen over the last 20 years (Table 3.1). Not only is there a smaller share of undernourished people today, but they are also less so than in 1990–1992. Globally, the depth of the food deficit declined 28%—from 130 kCal/capita/day in 1990–1992 to 94 kCal/capita/day in 2010–2012. In Asia, the depth of the food deficit declined by as much as 37% over the period, while in Africa the decline was only 10%—making the depth of food deficit there among the highest in the world. Among Asian economies, the variation is significant. Southeast Asia shows a 64% reduction in food deficit from 214 kCal/capita/day to 77 kCal/capita/day, while the food deficit in South Asia declined by only 27% from 174 kCal/capita/day to 127 kCal/capita/day. South Asia's food deficit

Figure 3.4b: **Depth of Food Deficit and Income, 2010–2012**



GDP = gross domestic product, N = sample size, R-sq = R-squared.

Notes:

1. GDP per capita is based on GDP measured in constant 2005 PPP$. Average GDP per capita for 2010–2012 is shown.
2. Depth of food deficit is defined as the mean difference between actual caloric intake and minimum daily caloric requirement among those whose caloric intake is below the minimum daily requirement. It is expressed in kCal/capita/day. Average depth of food deficit for 2010–2012 is shown.
3. The line shown is obtained from the linear regression of the log of depth of food deficit (y) averaged for 2010–2012 on the log of GDP per capita (x) averaged for 2010–2012. The regression results are embedded in the chart. The coefficient on log of average GDP per capita is statistically significant at the 1% level of significance.
4. Economies in Asia and the Pacific are shown in brown.
5. Refer to Appendix B for a list of three-character economy codes.

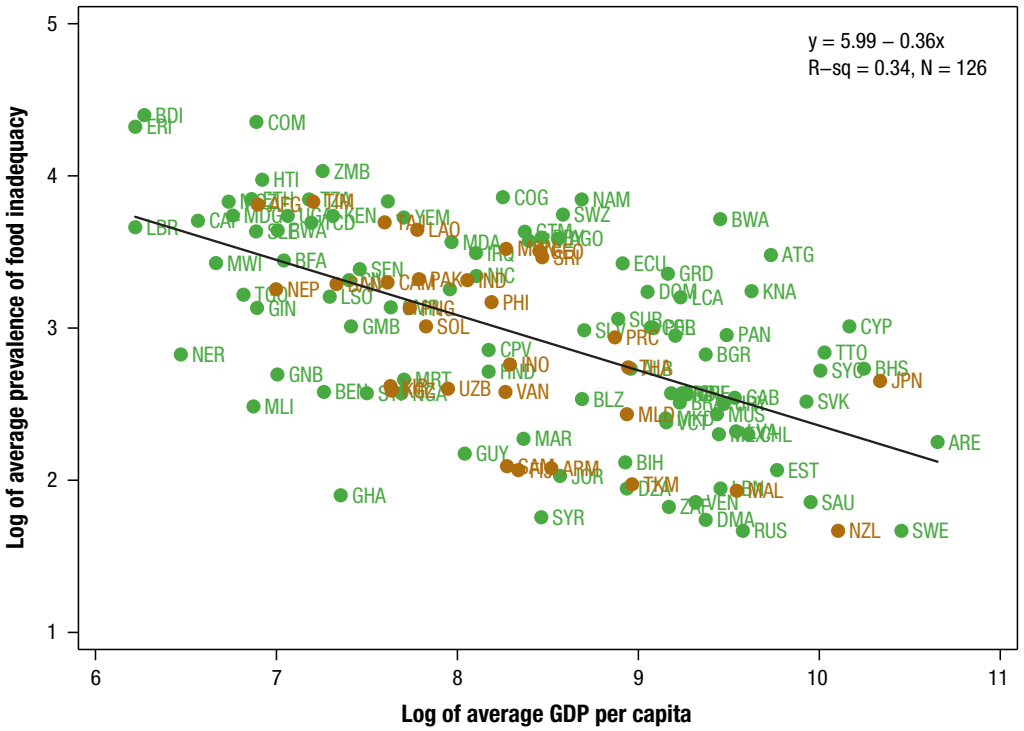
Sources: ADB estimates based on depth of food deficit data from the FAO Food Security Indicators, http://www.fao.org/economic/ess/ess-fs/ess-fadata/en/ (accessed 23 April 2013); and GDP data from the World Bank WDI, http://data.worldbank.org/data-catalog/world-development-indicators accessed (22 April 2013).

depth was below Southeast Asia's in 1990–1992 but higher than that in Southeast Asia by 2010–2012.

Dietary Diversity and Nutrition: Better Income, Better Food

With affluence and urbanization, Asians have developed an appetite for more nutritious and balanced meals. As income grows, so does dietary diversity—the relationship between the number of food groups consumed and total household per capita income is significant and positive (Hoddinott and Yohannes 2002). Based on household surveys in developing economies (FAO 2012), the households in the highest per capita income quintile have a

Figure 3.4c: **Prevalence of Food Inadequacy and Income, 2010–2012**



GDP = gross domestic product, N = sample size, R-sq = R-squared.

Notes:

1. GDP per capita is based on GDP measured in constant 2005 PPP$. Average GDP per capita for 2010–2012 is shown.
2. Prevalence of food inadequacy is measured as the percentage of the population that is at risk of not meeting the food requirements for normal physical activity. Prevalence of food inadequacy is conceptually analogous to the prevalence of undernourishment but the caloric threshold is set to a higher level.
3. The line shown is obtained from the linear regression of the log of prevalence of food inadequacy (y) averaged for 2010–2012 on the log of GDP per capita (x) averaged for 2010–2012. The regression results are embedded in the chart. The coefficient on log of average GDP per capita is statistically significant at the 1% level of significance.
4. Economies in Asia and the Pacific are shown in brown.
5. Refer to Appendix B for a list of three-character economy codes.

Sources: ADB estimates based on prevalence of food inadequacy data from the FAO Food Security Indicators, http://www.fao.org/economic/ess/ess-fs/ess-fadata/en/ (accessed 23 April 2013); and GDP data from the World Bank WDI, http://data.worldbank.org/data-catalog/world-development-indicators (accessed (22 April 2013).

more diversified diet. Economies with higher GDP per capita have more diversified sources of dietary energy supply[8] (Figure 3.6). The figure shows most of the economies are below the 45-degree line—that is, for these economies, the food basket was more diversified in 2009 than it was in 1961, and the pattern holds at all income levels. Despite this, higher-income economies continue to have a more diversified income basket—as seen by the group of economies at the bottom left-hand side of the scatter plot.

8 Diversity in dietary energy supply is measured using the Herfindahl–Hirschman Index (HHI), calculated as the sum of the squares of the shares of caloric intake from different kinds of food. The lower the HHI, the more diversified the sources of caloric intake.

Table 3.1: **Undernourishment and Depth of Food Deficit**

Region		1990–1992	2000–2002	2010–2012
World	Prevalence	18.6	14.9	12.5
	Depth	130	106	94
Asia and the Pacific	Prevalence	23.7	17.6	13.9
	Depth	165	125	104
Caucasus and Central Asia	Prevalence	12.8	14.5	7.4
	Depth	…	98	51
East Asia	Prevalence	20.8	14.3	11.5
	Depth	151	98	77
South Asia	Prevalence	26.8	21.3	17.6
	Depth	175	150	127
Southeast Asia	Prevalence	29.6	19.2	10.9
	Depth	214	132	77
Pacific	Prevalence	13.6	15.9	12.1
	Depth	82	98	74
Africa	Prevalence	27.3	25.1	22.9
	Depth	195	185	175
Latin America and the Caribbean	Prevalence	14.6	11.2	8.3
	Depth	98	75	59

… = not available.

Notes:
1. Prevalence of undernourishment is defined as the proportion of the population with a caloric intake less than the minimum daily requirement, and is expressed in percent.
2. Depth of food deficit is defined as the mean difference between actual caloric intake and minimum daily caloric requirement among those whose caloric intake is below the minimum daily requirement, and is expressed in kCal/capita/day.
3. Regional groupings are as defined by the FAO, and are different from those in Appendix A: South Asia includes Iran; Southeast Asia includes Timor-Leste; West Asia (called "Middle East" in Appendix A) includes Turkey, with the West Asia subregion included in the aggregated estimates for Asia; and Pacific includes non-ADB members in addition to the economies listed in Appendix A but excludes Australia and New Zealand.

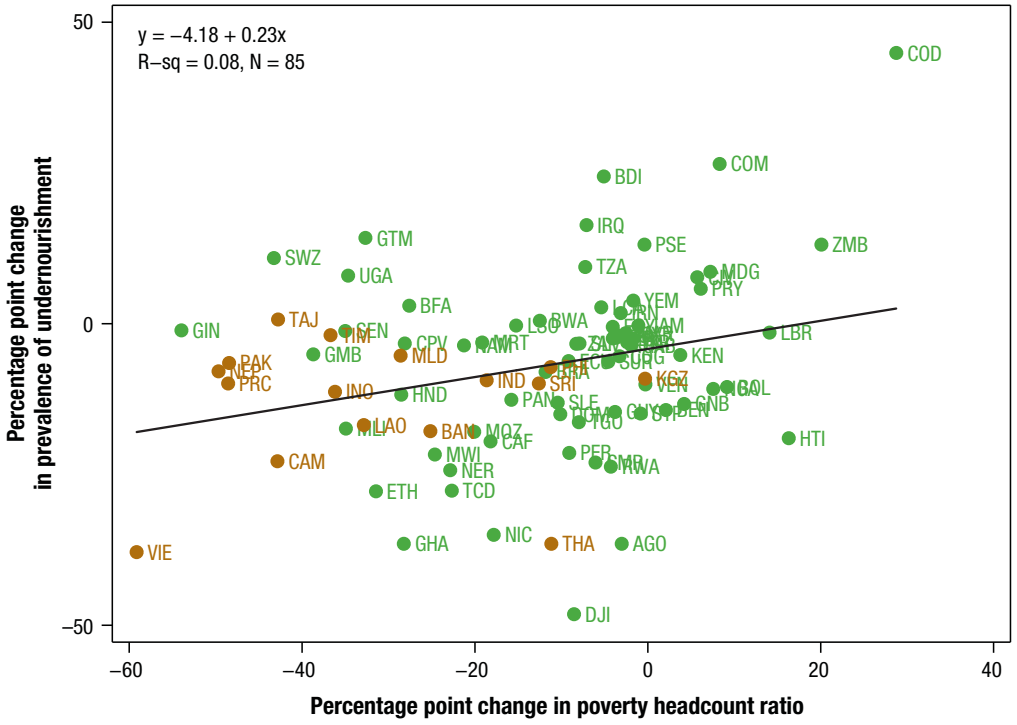
Source: FAO Food Security Indicators. http://www.fao.org/economic/ess/ess-fs/ess-fadata/en/ (accessed 23 April 2013).

In addition, evidence shows that as per capita income increases, the contribution of grains to total caloric intake per capita decreases (Figure 3.7a). On the other hand, that of animal-sourced foods (including meat, fish, dairy products, and eggs) increases (Figure 3.7b), together with that of fruits and vegetables.

The share of cereals in total caloric intake has declined significantly in Asia over the past 2 decades (Figure 2.2). East Asia shows a stark decline in its share of cereals in total caloric intake, showing instead an increase in the share of fruits and vegetables and animal-sourced calories. The changes are even more dramatic if viewed since 1961.

Evidence shows that economies with higher per capita incomes have greater supply of protein in their caloric intake (Figure 3.8a), and protein supply in Asia and the Pacific

Figure 3.5: **Change in Poverty and Change in Prevalence of Undernourishment in Low- and Middle-Income Economies, 1990–2012**



N = sample size, R-sq = R-squared.

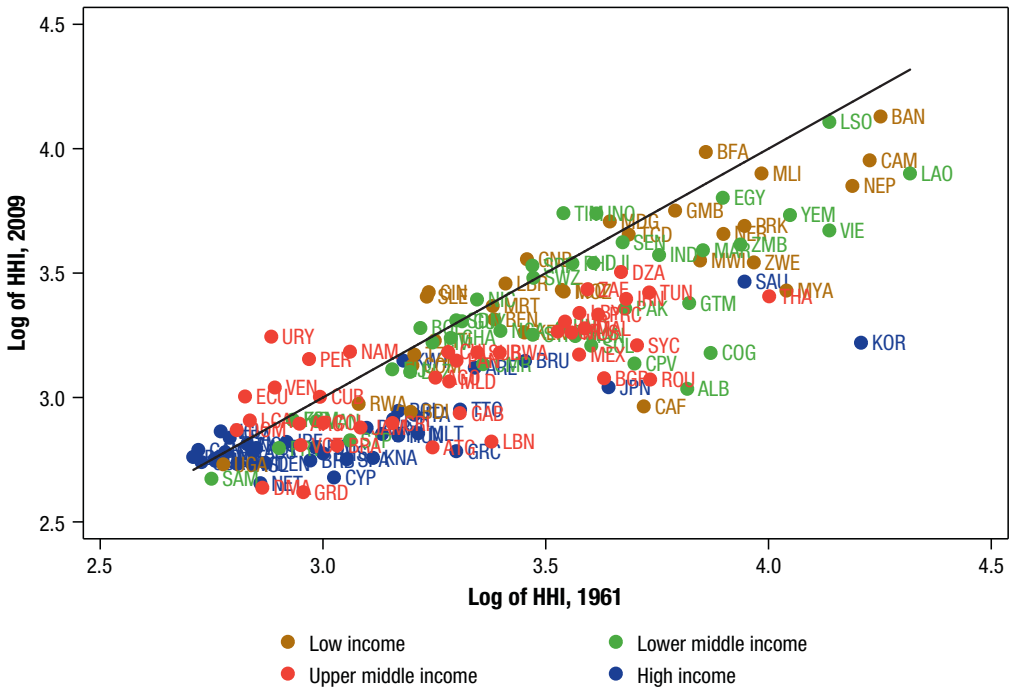
Notes:

1. Prevalence of undernourishment is defined as the proportion of the population with a caloric intake less than the minimum daily requirement, and is expressed in percent.
2. Poverty headcount ratio is the proportion of the population living on less than $1.25 a day (2005 PPP), and is expressed in percent.
3. Percentage point change is computed as the difference between the average values for 2010–2012 and 1990–1992 for prevalence of undernourishment, and between the values for 2010 and 1990 for poverty headcount ratio.
4. The line shown is obtained from the linear regression of the percentage point change in prevalence of undernourishment (y) during 1990–2012 on the percentage point change in poverty headcount ratio (x) during 1990–2010. The regression results are embedded in the chart. The coefficient on percentage point change in poverty headcount ratio is statistically significant at the 5% level of significance.
5. Economies in Asia and the Pacific are shown in brown.
6. Refer to Appendix B for a list of three-character economy codes.

Sources: ADB estimates based on undernourishment data from the FAO Food Security Indicators, http://www.fao.org/economic/ess/ess-fs/ess-fadata/en/ (accessed 23 April 2013); and poverty estimates from the PovcalNet, http://iresearch.worldbank.org/PovcalNet/index.htm?1 (accessed 23 April 2013).

increased sharply with income growth. Moreover, as income increases, this protein is increasingly sourced from animals (Figure 3.8b). The most visible increases in share of animal-sourced protein to total protein supply have been in East and Southeast Asia. Most of the increase in demand for animal protein by 2030 and beyond is expected to come from developing Asian economies (FAO 2011).

Figure 3.6: **Diversification in Sources of Caloric Intake, 1961 and 2009**



HHI = Herfindahl–Hirschman Index.

Notes:
1. The straight line shown in the chart is a 45-degree line.
2. The HHI was multiplied by 100 before taking logs.
3. Refer to Appendix B for a list of three-character economy codes.

Source: ADB estimates based on the Food Balance Sheets, FAOSTAT, http://faostat.fao.org/site/368/default.aspx#ancor (accessed 10 April 2013).

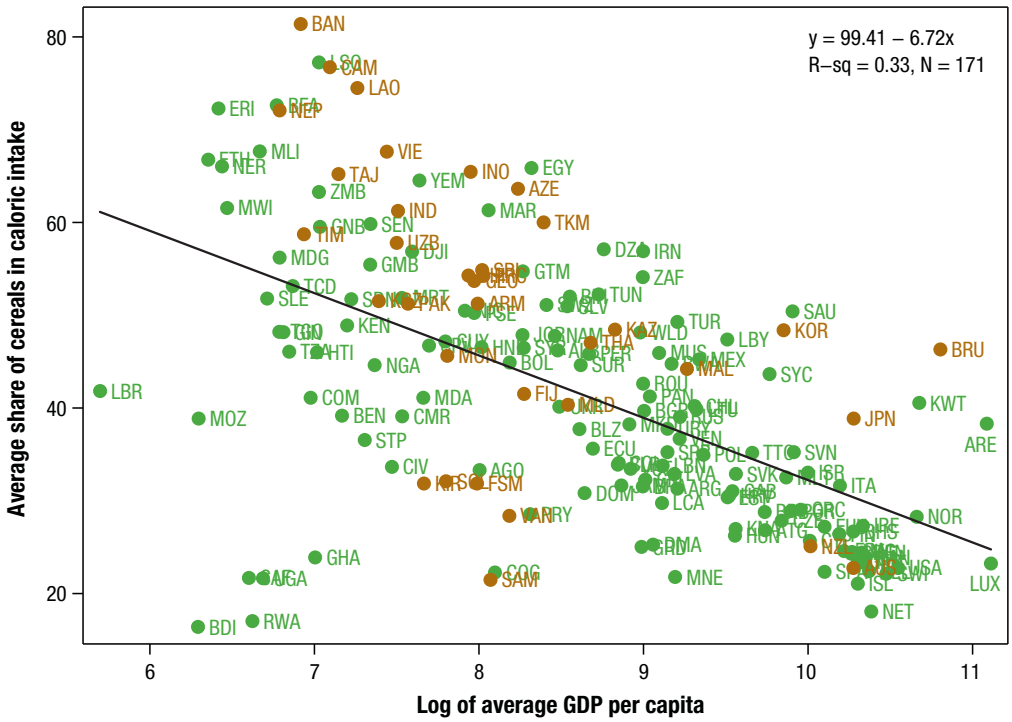
Nutrition, Health, and Development

Food security—the ability to access food of sufficient quantity and quality to satisfy nutritional needs—ranks high on the region's development agenda. Nutritionists emphasize that food security is about more than just caloric intake. Nutrition security is about meeting, but not exceeding, dietary requirements across a range of essential nutrients. Nutrition insecurity can exist even in the presence of food abundance (Neufeld, Chowdhury, and Ruel 2012). A growing number of studies suggest the increased intake of meat and dairy products poses a public health problem in many developing economies (Mendez and Popkin 2004).

Despite increasing affluence in Asia, large segments of the population remain hungry, and indicators such as child and maternal undernutrition show that the region is lagging in terms of achieving nutrition security. The focus for food security in the region should be on meeting nutritional needs, especially among vulnerable groups. In Asia, 14% of the population is undernourished, compared with 12.5% globally.[9] Moreover, a significant

9 This is based on the FAO Food Security Indicators (http://www.fao.org/economic/ess/ess-fs/en/ [accessed on 23 April 2013]). Here, the definition of Asia is based on FAO's regional grouping, whereby Asia includes the Middle East and Turkey.

Figure 3.7a: **Share of Cereals in Total Caloric Intake and GDP per Capita, 1991–2009**



GDP = gross domestic product, N = sample size, R-sq = R-squared.

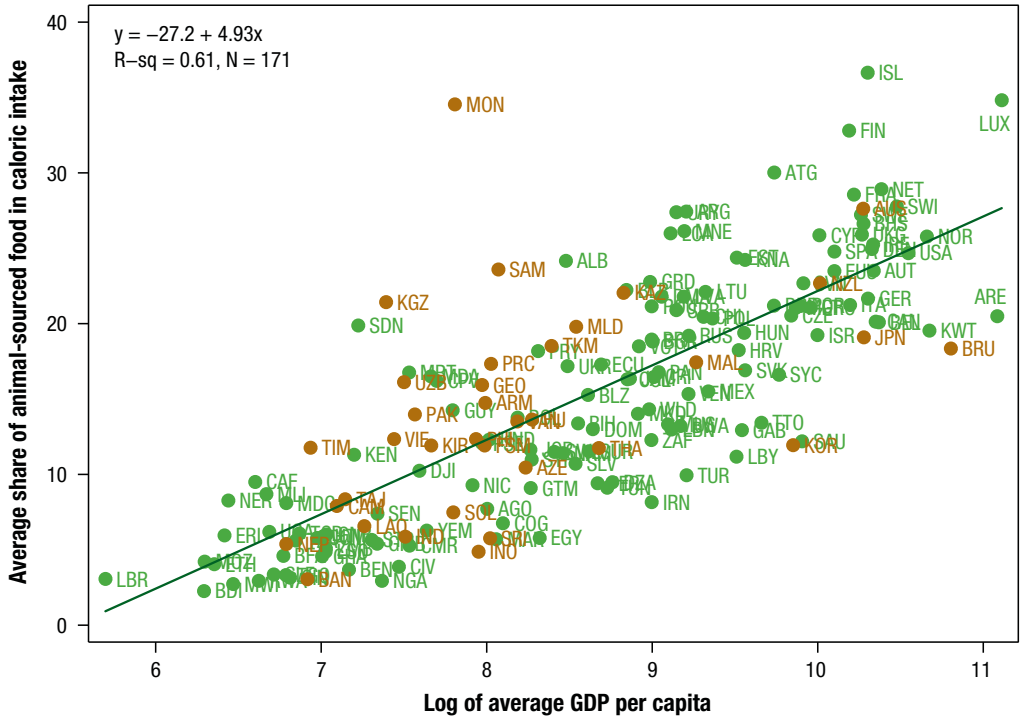
Notes:
1. GDP per capita is based on GDP measured in constant 2005 PPP$.
2. The line shown is obtained from the linear regression of the share of cereals in total caloric intake (y) averaged for 1991–2009 on the log of average GDP per capita (x) for 1991–2009. The regression results are embedded in the chart. The coefficient on log of GDP per capita is statistically significant at the 1% level of significance.
3. Economies in Asia and the Pacific are shown in brown.
4. Refer to Appendix B for a list of three-character economy codes.

Sources: ADB estimates based on consumption data from the Food Balance Sheets, FAOSTAT, http://faostat.fao.org/site/368/default.aspx#ancor (accessed 10 April 2013); and GDP data from the World Bank WDI, http://data.worldbank.org/data-catalog/world-development-indicators (accessed 22 April 2013).

decline in poverty incidence has not been matched by a corresponding decrease in the prevalence of undernourishment.

Adequate nutrition not only benefits individual health and survival, but also collective human capital and economic development. This is particularly true for children. Survey-based data show high levels of stunting—height-for-age more than two standard deviations below the WHO Child Growth Standards median—in children under 5 years of age in South and Central Asia, and parts of Southeast Asia (Neufeld, Chowdhury, and Ruel 2012). In South Asia, 40% of children are stunted—over 5% severely. High levels of anemia (low hemoglobin in blood due to iron deficiency) and vitamin A deficiency exist in Cambodia, India, Myanmar, Nepal, and Pakistan. Not far behind are Bangladesh, Indonesia, the Philippines, and Viet Nam.

Figure 3.7b: **Share of Animal-Sourced Food in Total Caloric Intake and GDP per Capita, 1991–2009**



GDP = gross domestic product, N = sample size, R-sq = R-squared.

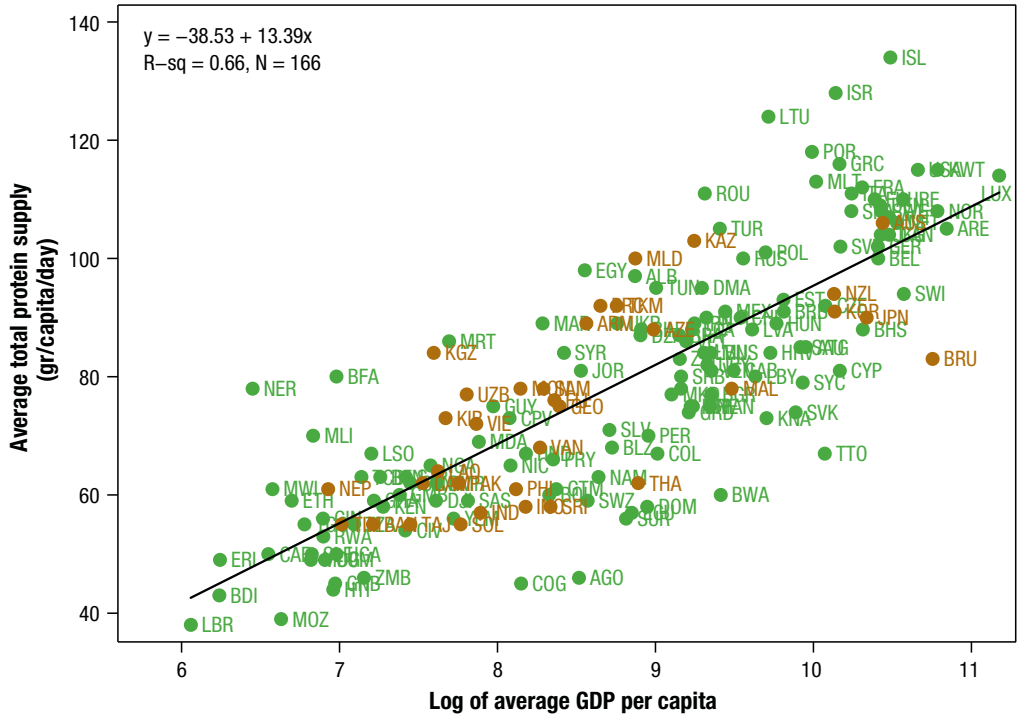
Notes:
1. GDP per capita is based on GDP measured in constant 2005 PPP$.
2. The line shown is obtained from the linear regression of the share of animal-sourced food in total caloric intake (y) averaged for 1991–2009 on the log of average GDP per capita (x) for 1991–2009. The regression results are embedded in the chart. The coefficient on log of GDP per capita is statistically significant at the 1% level of significance.
3. Economies in Asia and the Pacific are shown in brown.
4. Refer to Appendix B for a list of three-character economy codes.

Sources: ADB estimates based on consumption data from the Food Balance Sheets, FAOSTAT, http://faostat.fao.org/site/368/default.aspx#ancor (accessed 10 April 2013); and GDP data from the World Bank WDI, http://data.worldbank.org/data-catalog/world-development-indicators (accessed 22 April 2013).

There is an inverse relationship between per capita income and the percentage of stunted children aged 0–5 (Figure 3.9). Within Asia, Nepal (49.3%), India (47.9%), the Lao People's Democratic Republic (Lao PDR; 47.6%), and Bangladesh (46%) show the highest childhood stunting.

While nutritionists stress a proper mix of micronutrients, data on "average" nutrient intake does not accurately capture how important micronutrients are for child development. Aside from contributing to early death, childhood malnutrition plays a part in mental and physical impairment and a lifelong risk of chronic disease. These cannot always be remedied by improved diets later. In economic terms, childhood malnutrition impedes the formation of human capital through investment in education, with ramifications for economic growth.

Figure 3.8a: **Protein Supply and GDP per Capita, 2007–2009**



GDP = gross domestic product, gr = gram, N = sample size, R-sq = R-squared.

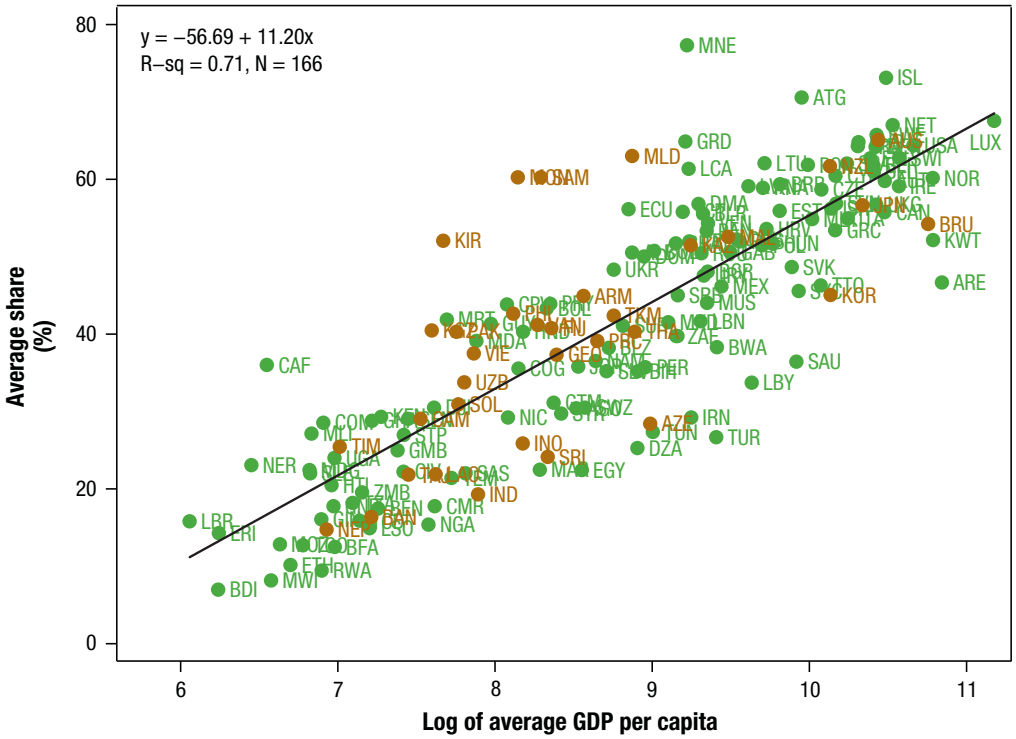
Notes:
1. GDP per capita is based on GDP measured in constant 2005 PPP$.
2. The line shown is obtained from the linear regression of the total protein supply (y) averaged for 2007–2009 on the log of average GDP per capita (x) for 2007–2009. The regression results are embedded in the chart. The coefficient on log of GDP per capita is statistically significant at the 1% level of significance.
3. Economies in Asia and the Pacific are shown in brown.
4. Please refer to Appendix B for a list of three-character economy codes.

Sources: ADB estimates based on protein supply data from the FAO Food Security Indicators, http://www.fao.org/economic/ess/ess-fs/ess-fadata/en/ (accessed 23 April 2013); and GDP data from the World Bank WDI, http://data.worldbank.org/data-catalog/world-development-indicators (accessed 22 April 2013).

Undernourishment in childhood has been shown to be significantly linked with lower school performance, lower salaries and income in adult life, and lower birth weight for the next generation (Victoria et al. 2008).

While many Asian economies continue to struggle with maternal and child undernutrition, they also face the double burden of malnutrition—the coexistence of stunted children and overweight adults within the same community. Across populous countries in Asia—including India, Indonesia, and the Philippines—the prevalence of undernutrition remains persistently high. But the problems of overnutrition are also surfacing, mainly in urban areas (FAO 2006). In the PRC, much progress has been made on undernutrition, but obesity is a growing concern. The Pacific islands show some of the highest obesity rates in the world—more than 50% of the population is overweight in at least 10 Pacific island countries (WHO 2010).

Figure 3.8b: **Share of Animal-Sourced Protein in Total Protein Supply and GDP per Capita, 2007–2009**



GDP = gross domestic product, N = sample size, R-sq = R-squared.

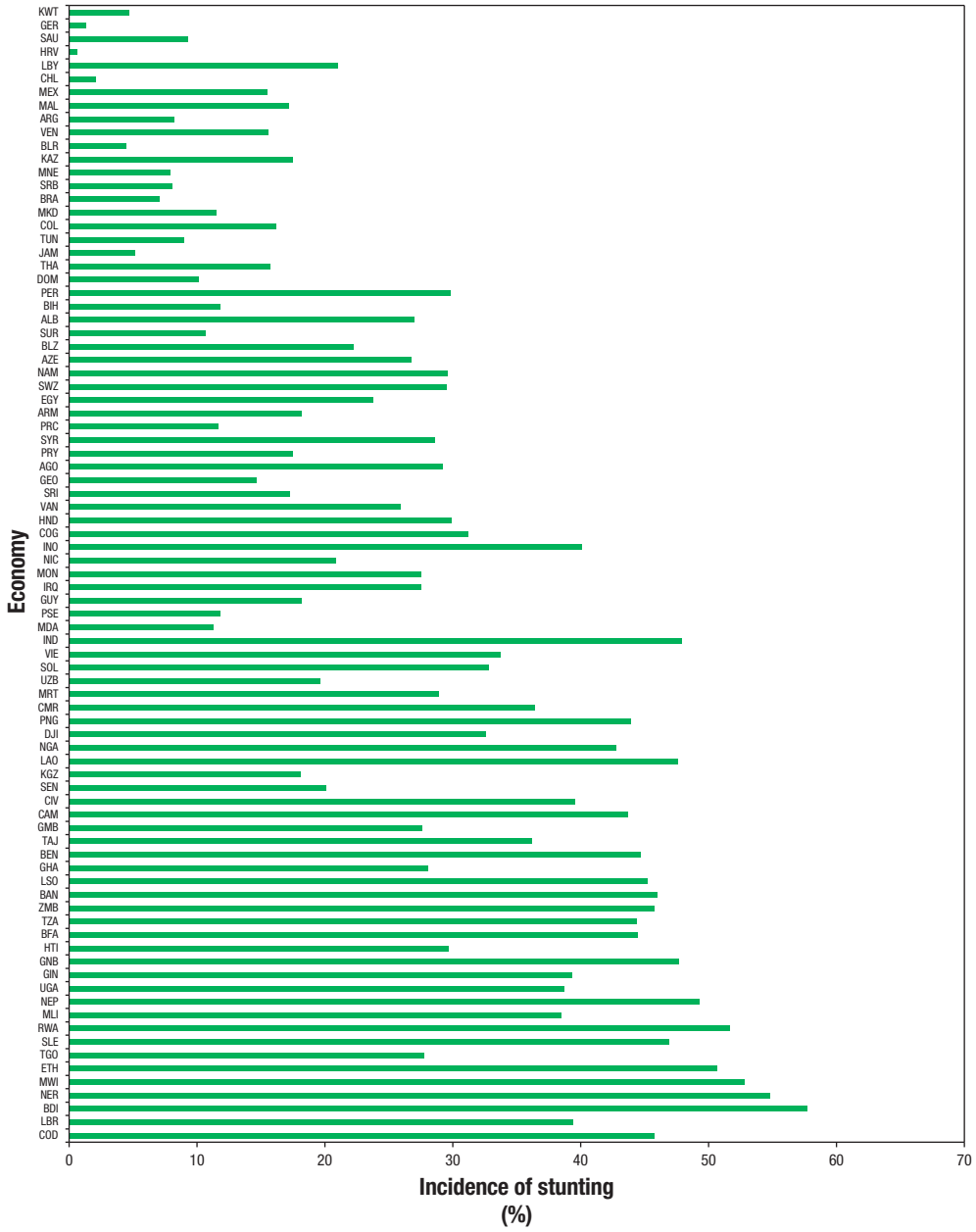
Notes:
1. GDP per capita is based on GDP measured in constant 2005 PPP$.
2. The line shown is obtained from the linear regression of the share of average animal-sourced protein in total protein supply averaged for 2007–2009 (y) on the log of average GDP per capita (x) for 2007–2009. The regression results are embedded in the chart. The coefficient on log of GDP per capita is statistically significant at the 1% level of significance.
3. Economies in Asia and the Pacific are in brown.
4. Please refer to Appendix B for a list of three-character economy codes.

Sources: ADB estimates based on protein supply data from the FAO Food Security Indicators, http://www.fao.org/economic/ess/ess-fs/ess-fadata/en/ (accessed 23 April 2013); and GDP data from the World Bank WDI, http://data.worldbank.org/data-catalog/world-development-indicators (accessed 22 April 2013).

Nutrition trends are worrisome in many developing countries. Obesity, diabetes, and other noncommunicable diet-related diseases have been rising due to changing dietary patterns and lifestyles. While dietary diversity during the nutrition transition is welcome, ongoing dietary shifts have largely corresponded to increased fat content sourced from animal fat and oil. Sharp increases in the consumption of sugar and other sweet products, as well as in that of certain processed foods are also contributing to growing rates of obesity and diabetes.

Malnutrition, whether under- or overnutrition, is a significant threat to public health. Many developing countries must combat both simultaneously. Undernutrition and micronutrient deficiencies—especially among children—are stubbornly high in some pockets of the

Figure 3.9: **Percentage of Children Under 5 Who Are Stunted, 2005–2007**



Notes:

1. Estimates are percentages of stunting (height-for-age more than two standard deviations below the World Health Organization [WHO] Child Growth Standards median) among children aged 0–5 years. Average for 2005–2007 is shown to maximize economy coverage.
2. Economies are arranged in descending order (top to bottom) based on their gross domestic product (GDP) per capita (constant 2005 PPP$) for 2005–2007.
3. Please refer to Appendix B for a list of three-character economy codes.

Sources: Data on stunting prevalence from the FAO Food Security Indicators, http://www.fao.org/economic/ess/ess-fs/ess-fadata/en/ (accessed 23 April 2013); and GDP data from the World Bank WDI, http://data.worldbank.org/data-catalog/world-development-indicators (accessed 22 April 2013).

region. Where problems are emerging, effective control is key. The challenge is to develop effective programs and policies that are specific to a country context. For example, reducing child and adult undernutrition and micronutrient deficiencies should remain a top priority in India, Indonesia, and the Philippines. But more focused efforts should also be initiated to limit the emergence of obesity in urban areas. In the PRC, where obesity is rising and increasingly affecting children, efforts should be directed toward improving nutritional awareness, ensuring that healthy food options are affordable and accessible, and educating consumers about the long-term health impacts of obesity.

Food Crises and Their Impact on Poverty

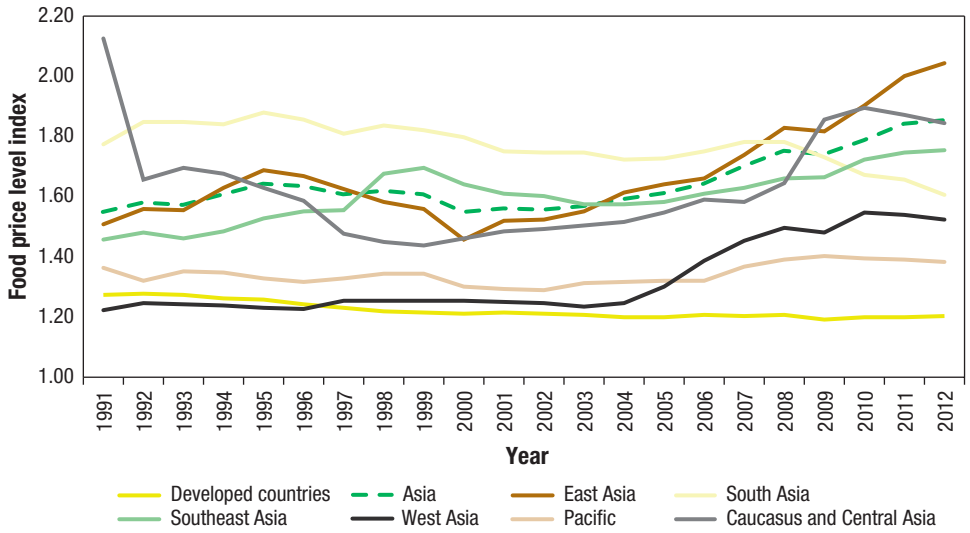
A major determinant of consumers' economic access to food is price. High and rising food prices have regressive distributional effects. For those near the poverty line, higher prices can push them back into poverty and also increase the depth of the food deficit. In addition, volatility creates uncertainty about future affordable meals, adding to food insecurity. The food price index across various Asian subregions declined during the 1990s and early 2000s (Figure 3.10), mirroring the secular decline in global food prices. Price hikes followed in the latter half of the first decade of the 2000s. Regional data on food price indexes also show increased price volatility in the latter half of that decade (Figure 3.11). It is interesting that, on average, food prices were both higher and more volatile in developing countries than developed countries.

Food price inflation erodes household purchasing power—especially for those with low incomes—and can undermine gains in poverty reduction and human development. Many people who were poor prior to price increases may fall on the verge of hunger and malnutrition, while those barely above the poverty line may slip back into poverty. High food prices, even temporarily reducing disposable income, may force households to sell assets, reduce spending on health, or remove children from school to secure food. These temporary shocks can have permanent effects on a family's ability to escape poverty. At the macroeconomic level, higher prices hurt countries that provide substantial food subsidies. Large subsidies crowd out public investment in other priority sectors, such as health, education, and infrastructure. Volatile food prices also exacerbate malfunctioning markets, which deter farmers from making productive agricultural investments. Thus, risk-averse farmers may opt for inefficient technologies with low returns rather than risk investing scarce resources in better technology with the promise of higher output.

For the average household in the developing world, food expenditures absorb more than half the total budget. For the poor, the share is even higher. Households in Asia and the Pacific below the poverty line allocate 60%–70% of their budget to food. The poor are thus hurt disproportionately more from food price inflation.

Assuming price stability, poverty reduction depends on two factors: average income (or expenditure) and how it is distributed. An increase in average income without a change in distribution reduces poverty, while an increase in income inequality without a change in average income increases poverty. However, changes in food and nonfood prices also alter purchasing power, influencing the percentage of people living below the poverty line. Moreover, differences in shares of food and nonfood consumption across income groups—

Figure 3.10: **Food Price Indexes in Subregions of Asia and the Pacific, 1991–2012**



Notes:
1. The FAO calculates the domestic food price level index by dividing the food purchasing power parity (FPPP) by the general PPP.
2. Regional groupings are as defined by the FAO, and are different from those in Appendix A: South Asia includes Iran; Southeast Asia includes Timor-Leste; West Asia (called "Middle East" in Appendix A) includes Turkey, with the West Asia subregion included in the aggregated estimates for Asia; and for the Pacific, only Fiji has data, with Australia and New Zealand classified under "Developed Countries".

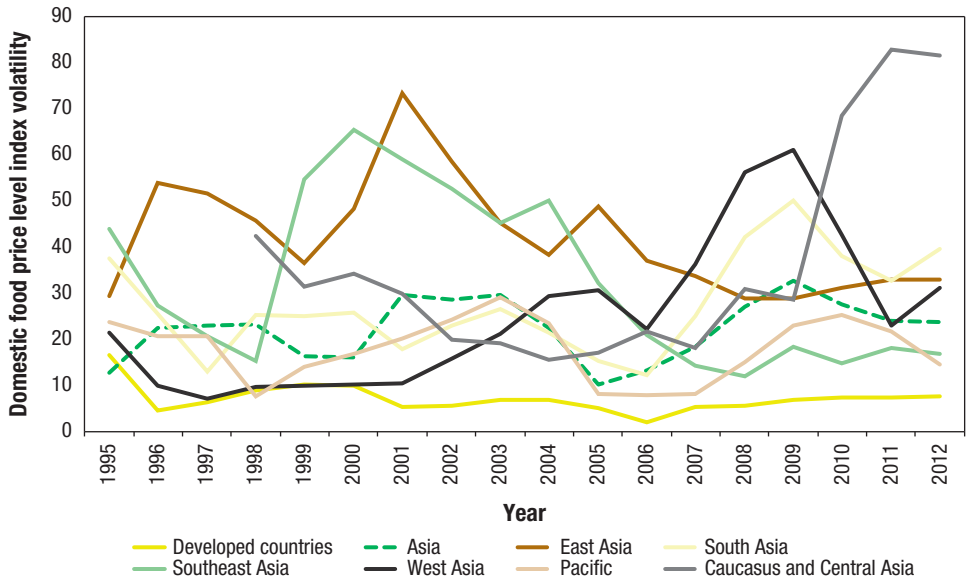
Source: FAO Food Security Indicators. http://www.fao.org/economic/ess/ess-fs/ess-fadata/en/ (accessed 23 April 2013).

again, the poor spend relatively more on food—mean that a larger change in food versus nonfood prices will also affect real income distribution. In this context, a change in poverty can be decomposed into three factors: (i) a pure income effect—measuring the impact of changes in nominal income on poverty, assuming food and nonfood price stability; and (ii) food and (iii) nonfood price effects—measuring the impact of price changes on poverty, assuming nominal incomes are stable.

This decomposition methodology was used to analyze how changes in income—and food and nonfood prices—affected the proportion of those living below the $1.25-a-day (2005 PPP) poverty line (ADB 2012). In all the 17 economies examined (Table 3.2), mean expenditure increased—mostly during the second half of the first decade of the 2000s—resulting in lower poverty rates (Figure 3.12).

An increase in food and nonfood prices had an offsetting effect on poverty reduction, however. The income effect dominated the other two price effects, leading to a net reduction in poverty in nearly all the 17 economies. For example, the poverty rate fell by 6.19% per year during 2006–2009 in the Philippines. The reduction was due to three factors: (i) an increase in mean household expenditure helped reduce the poverty rate by 16.08%, but (ii) an increase in food prices increased poverty rate by 8.71%, and (iii) an increase in

Figure 3.11: **Food Price Volatility in Subregions of Asia and the Pacific, 1995–2012**



Notes:
1. Domestic food price volatility is a measure of variation of the domestic food price level index (Figure 3.10). The FAO calculates domestic food price volatility as the standard deviation of the deviations from the trend in domestic food price level index over the previous 5 years.
2. Regional groupings are as defined by the FAO, and are different from those in Appendix A: South Asia includes Iran; Southeast Asia includes Timor-Leste; West Asia (called "Middle East" in Appendix A) includes Turkey, with the West Asia subregion included in the aggregated estimates for Asia; and for the Pacific, only Fiji has data, with Australia and New Zealand classified under "Developed Countries".

Source: FAO Food Security Indicators. http://www.fao.org/economic/ess/ess-fs/ess-fadata/en/ (accessed 23 April 2013).

nonfood prices boosted it by 1.18%. The net effect was an annual poverty rate reduction of 6.19% between 2006 and 2009, with the income effect being the main driver.

A similar decomposition methodology was used to examine the change in those living below the poverty threshold. For this exercise, the effect of population growth on the change in poverty headcount was added to the three factors. A change in the number of poor would now be explained by four factors: (i) income, (ii) food prices, (iii) nonfood prices, and (iv) change in population.

The estimates show that 30.4 million people escaped poverty in developing Asia annually during the first decade of the 2000s (Table 3.3). Again, the income effect was most significant; indeed, if price and population had not increased, the rise in mean household income during that decade would have led 244.1 million out of poverty annually. However, higher food prices in the second half of that period would have pushed 111.7 million into poverty annually had there been no income, nonfood price, or population effect. Likewise, the rise in nonfood prices would have added 95.46 million poor each year. Population growth during the second half of the first decade of the 2000s also added 6.5 million

Table 3.2: **Change in the Percentage of Poor Based on the $1.25-a-Day (2005 PPP) Poverty Line**

Country	Survey Period		Percentage of Poor		Annual Growth (%)
	Base	Terminal	Base	Terminal	
Armenia	2005	2008	3.98	1.28	–22.61
Azerbaijan	2001	2008	6.32	0.43	–13.31
Bangladesh	2005	2010	50.47	43.25	–2.86
Bhutan	2003	2007	26.23	10.22	–15.26
PRC–Rural	2005	2008	26.11	22.27	–4.9
PRC–Urban	2005	2008	1.71	0.89	–15.98
Fiji	2005	2008–09	29.16	5.88	–13.31
Georgia	2002–03	2008	15.98	15.27	–1.48
India–Rural	2005	2010	43.83	34.28	–3.96
India–Urban	2004–05	2010	36.16	28.93	–3.64
Indonesia–Rural	2005	2010	24.01	17.75	–5.21
Indonesia–Urban	2005	2010	18.67	18.33	–0.36
Kazakhstan	2006	2009	0.43	0.11	–24.81
Kyrgyz Republic	2006	2009	5.94	6.23	1.63
Lao PDR	2002	2008	43.96	33.88	–3.82
Nepal	2003	2010	53.13	24.82	–7.61
Pakistan	2004–05	2007–08	22.59	21.04	–2.29
Philippines	2006	2009	22.62	18.42	–6.19
Sri Lanka	2002	2006–07	13.95	7.04	–11.01
Thailand	2006	2009	1.01	0.37	–21.12

PRC = People's Republic of China, Lao PDR = Lao People's Democratic Republic, PPP = purchasing power parity.

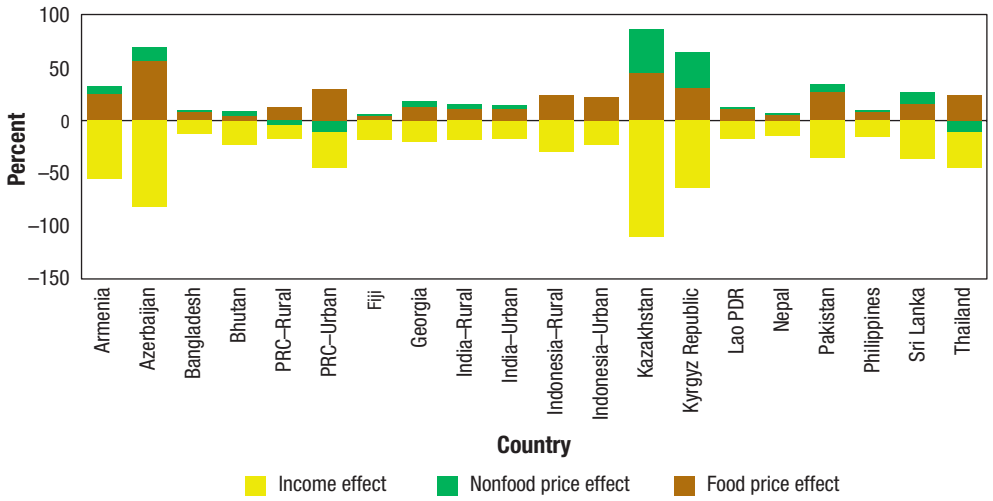
Source: ADB. 2012. *Food Security in Asia and the Pacific: Key Challenges and Policy Options*. Manila: ADB.

people annually to the ranks of the poor. It was the strength of the income effect, however, that ultimately led to a net 30.4 million annual decrease in the number of people below the $1.25-a-day (2005 PPP) poverty line in developing Asia—offsetting the negative impact on poverty of price and population increases.

In sum, over 110 million more people in Asia could have left poverty behind had food prices not increased during the latter part of the first decade of the 2000s. Although the increase in food prices in that period did not lead to a net increase in Asia's poverty rates, it did slow poverty reduction. The net reduction in developing Asia's overall poverty rates in the later part of that period can be largely attributed to the increase in mean incomes across the region. In this context, food and nonfood price inflation effectively hampered the reduction in poverty rates.

Food price increases affect poverty incidence in two quite disparate ways. On one hand, they harm poor consumers—both urban and rural—who spend a large share of their budgets on food. On the other hand, price increases also raise the incomes of poor farmers

Figure 3.12: **Change in Poverty Due to Food Price, Nonfood Price, and Income Effects (%)**



PRC = People's Republic of China, Lao PDR = Lao People's Democratic Republic.

Note: Poverty impact estimates were derived from the price elasticity of poverty, which indicates the percentage increase in poverty when food prices increase by 1%. This elasticity is estimated for the poverty headcount ratio for each of the 17 economies.

Source: ADB. 2012. *Food Security in Asia and the Pacific: Key Challenges and Policy Options*. Manila: ADB.

and nonfarmers by raising the returns to the factors of production they own. In developing countries, the majority of the poor reside in rural areas, and a high proportion of them directly depend on agriculture. It is not obvious, a priori, which of these opposing effects—negative expenditure effects or positive income effects—is larger. There will be both losers and gainers. Clearly, the way large external price shocks affect the structure of household welfare, and thus poverty, is inherently a general equilibrium problem. General equilibrium models for Thailand and Indonesia demonstrate how domestic policy influences the effect of food price spikes on poverty incidence (Box 3.1).

The general equilibrium analysis shows that food price hikes increased poverty incidence in both Thailand and Indonesia, but by surprisingly small amounts. Some of the poor (notably farmers) gained from price increases while others (net consumers) lost. By insulating domestic markets from international markets, it is possible to prevent international price changes from affecting local markets. But these insulating policies can themselves hurt the poor. Indonesia's rice import policy illustrates this possibility.

Impact of High and Volatile Food Prices on Health Indicators

Rising food prices can have a significant, adverse impact on people's health in developing countries. As discussed earlier, inadequate food intake undermines health, retards human development, and lowers labor productivity for the economy in the long term. Food price

Table 3.3: **Change in Poor Population**
(millions)

Country	Change in the Number of Poor People Due to				Net Effect on Poverty
	Population	Food Price	Nonfood Price	Income	
Armenia	0.0000	0.03	0.03	–0.09	–0.03
Azerbaijan	0.0004	0.29	0.31	–0.67	–0.07
Bangladesh	0.7006	5.51	5.89	–13.43	–1.33
Bhutan	0.0018	0.01	0.01	–0.04	–0.02
PRC–Rural	–1.7289	24.92	8.06	–42.93	–11.67
PRC–Urban	0.1312	2.72	0.76	–4.92	–1.31
Fiji	0.0002	0.01	0.01	–0.05	–0.03
Georgia	0.0010	0.09	0.10	–0.20	–0.01
India–Rural	3.3077	40.37	45.38	–99.69	–10.63
India–Urban	2.5543	13.22	13.42	–30.85	–1.65
Indonesia–Rural	–0.2453	6.98	6.98	–14.03	–1.72
Indonesia–Urban	0.7141	4.65	3.72	–8.44	0.64
Kazakhstan	0.0002	0.03	0.05	–0.09	–0.02
Kyrgyz Republic	0.0027	0.10	0.17	–0.03	0.01
Lao PDR	0.0294	0.26	0.27	–0.62	–0.06
Nepal	0.1354	0.85	0.88	–2.80	–0.92
Pakistan	0.6024	9.40	8.78	–18.99	–0.20
Philippines	0.2812	1.72	1.38	–4.31	–0.94
Sri Lanka	0.0145	0.42	0.62	–1.33	–0.28
Thailand	0.0018	0.16	0.04	–0.34	–0.14
Total	**6.5049**	**111.74**	**95.46**	**–244.10**	**–30.40**

PRC = People's Republic of China, Lao PDR = Lao People's Democratic Republic.

Source: ADB. 2012. *Food Security in Asia and the Pacific: Key Challenges and Policy Options*. Manila: ADB.

shocks can also compromise maternal and child nutrition, mainly through a reduction in dietary quality and an increase in micronutrient deficiencies—and concomitant increases in infectious disease morbidity and mortality (Darnton-Hill and Cogill 2010).

A comprehensive assessment of the effects that food price inflation and volatility have on population health—measured by infant mortality rate, child mortality rate, and prevalence of undernourishment—was recently carried out (Lee et al., forthcoming). Using a panel dataset covering 63 developing countries from 2001 to 2010, the study found that a 1 percentage point increase in contemporaneous food price inflation leads to a 0.2% increase in infant and child mortality and a 0.4% increase in prevalence of undernourishment (Figure 3.13).

The study investigated how quickly health measures are affected by food price inflation. The adverse impact on the prevalence of undernourishment remained even after including one- and two-period lagged inflation rates. In fact, one-period lagged inflation had an additional

Box 3.1: The Cost of Food and Poverty—The Case of Thailand and Indonesia

Thailand is one of the world's largest food exporters; its products include the region's dominant staple, rice. Indonesia is exactly the opposite. Most of its staple food—rice, maize, cassava, soybeans, and sugar—are net imports, with most domestic production from small land holdings. Its agricultural exports have tended to be estate crops such as rubber, copra, and coffee. Other things being equal, the balance between net consumers and net producers of food in net importers, like Indonesia, is more heavily weighted in favor of consumers than in net food exporters, like Thailand. So the likelihood that food price hikes will raise poverty incidence would seem to be greater in Indonesia than Thailand.

Warr (2010a, 2010b) has estimated general equilibrium models designed to estimate the impact of price changes on poverty incidence.[a] The shocks applied to the two models are the percent changes in the international real prices of four commodities—rice, maize, soybeans, and sugar—from 2003 to 2008. During this period, real prices (the nominal price in dollars of the commodities deflated by Manufactures Unit Value [MUV] index[b]) increased by 212% for rice, 124% for maize, 117% for soybeans, and 62% for sugar (Table B3.1).

Even though the international price shocks were large, the results show that their simulated effects on poverty incidence were small. This is because the impact is the net effect on populations including groups that lose from price increases (net buyers) as well as those that gain (net sellers and others gaining from indirect income effects). Also, the net effects were either zero or positive, meaning that simulated poverty incidence either increased as a result of food price shocks or was unaffected at the degree of precision possible with these models.

It is helpful to focus on rice. In Thailand, the increase in the producer price of rice benefits sellers, while the consumer price increase harms net consumers. For those close to the poverty line, net consumers outnumber net sellers, even in rural areas. Net consumers are all rural people who do

Table B3.1: Thailand and Indonesia—Simulated Effects of Food Price Shocks on Poverty Incidence

Commodity	Rice	Maize	Soybeans	Sugar
Shock to International Price (%)	212	124	117	62

	Headcount Measure of Poverty Incidence (% of population)				
	Before Price Shock	Simulated Change in Poverty Incidence from Price Shock			
Thailand					
Urban	3.22	0.202	0.000	0.000	0.00
Rural	17.99	0.443	0.014	0.015	0.00
National	13.71	0.371	0.003	0.013	0.00
Indonesia					
Urban	13.60	0.008	0.016	0.044	0.049
Rural	20.20	0.001	0.179	0.047	0.066
National	17.19	0.004	0.105	0.045	0.058

Sources: See box source.

continued on next page

Box 3.1 *continued*

not own cultivated rice land, including all landless laborers. It also includes many small farmers who produce some rice but supplement consumption with purchased rice, using income derived from the sale of other agricultural products or, increasingly, nonfarm sources of income.

But others are affected as well, even those who neither produce nor consume rice. This is because real wages and returns on capital and land are affected throughout the economy. Urban poverty incidence increased marginally, from 3.2% to 3.4% of the urban population, while rural poverty incidence increased from 18.0% to 18.4%. The negative effect on poor consumers of rice outweighs the positive effect of the increased returns to fixed factors owned by poor rice producers and the small increase in unskilled wages.

In Indonesia, the estimated effects of the international rice price shock were very small. Its vulnerability to the price shock is determined by its policies on rice imports. Until the early 2000s, Indonesia was the world's largest rice importer. With the political shift to a more democratic form of government, the lobbying power of pro-farmer political groups initially led to heavy tariffs on rice imports. Then, in 2004, rice imports were officially banned, although limited quantities of imports are occasionally permitted (Warr 2005, 2011). By 2006, this policy increased domestic rice prices relative to world prices by about 37% (Fane and Warr 2009). The leaky rice import ban may be more usefully understood as a binding import quota, restricting imports to about one-tenth their previous volume—although the magnitude of the import restriction is regularly reviewed.

The import quota on rice meant that world price increases for rice were barely transmitted to Indonesian domestic markets. For rice, the import quota shielded domestic markets from the effects of the 2007–2008 global price shock, thereby averting the temporary increase in poverty incidence that would have occurred if, for example, the protectionist policy had been a fixed ad valorem tariff. But the import ban achieved this temporary benefit only at the expense of increasing domestic rice prices—in advance of the 2007–2008 international price increases—thereby permanently increasing poverty incidence.

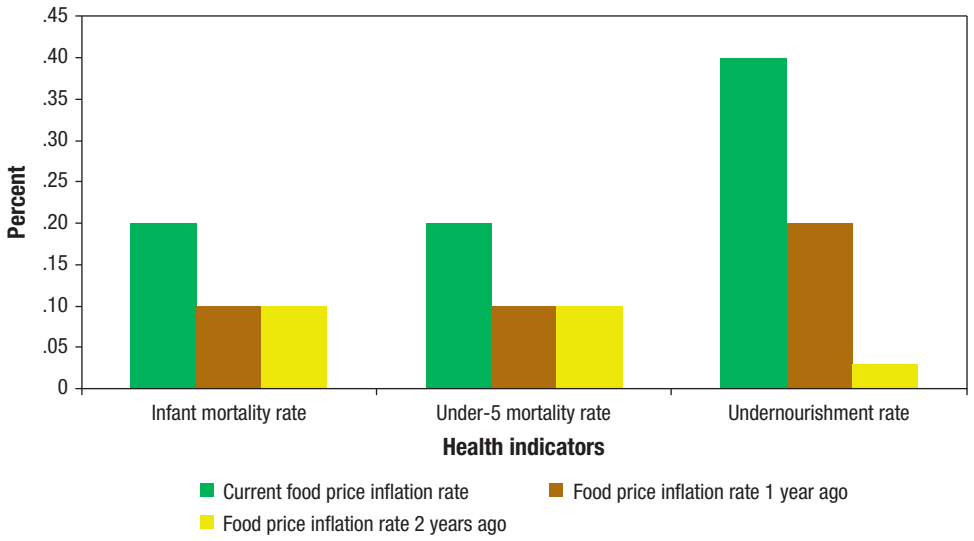
[a] A detailed description of the models can be found in the studies by Warr (2010a, 2010b). The model closure assumptions underlying the simulations are outlined in Warr (2008).
[b] The MUV index is an index of internationally traded manufactured goods prices.

Sources: Warr, P. 2010. Chapters on Indonesia and Thailand. In K. Anderson, J. Cockburn, and W. Marin, eds. *Agricultural Price Distortions, Inequality and Poverty*. Washington DC: World Bank.; and Warr, P. 2011. Food Security vs. Food Self-Sufficiency: The Indonesian Case. *The Indonesia Quarterly*. 39 (1, First Quarter). pp. 56–71.

impact on undernourishment. On the other hand, infant and child mortality seemed to be affected by past inflation, as the effect of contemporaneous inflation disappeared when one-period lagged inflation was included. Furthermore, the study showed that the impact of food prices is more severe in least developed countries, although the effect is moderated where agriculture has a greater share of GDP.

The effects of contemporaneous and lagged food price volatility on the three health indicators were also examined. Contemporaneous food price volatility was shown to increase infant and child mortality, but did not seem to affect the prevalence of undernourishment. However, the study found that when lagged food price volatility was included, infant and child mortality were mostly affected by the past terms of food price volatility, implying that it takes some time for food price volatility to affect mortality rates.

Figure 3.13: Impact of Higher Food Price Inflation on Health Indicators



Note: Figures show percentage change in health indicators for every 1 percentage point increase in the food price inflation rate.

Source: Lee et al. Forthcoming. Food Prices and Population Health in Developing Countries: An Investigation of the Effect of the Food Crisis Using a Panel Analysis. *ADB Economics Working Paper*. Manila: ADB.

The Role of Social Safety Nets

Most Asian countries use social safety nets of some kind, intended to shield poor and vulnerable groups from severe deprivation. As a percentage of GDP, social protection expenditures vary across developing Asia (ADB 2008)—from 1.3% in the Lao PDR, to 1.9% in Indonesia, 2.2% in the Philippines, 4.0% in India, 5.3% in Bangladesh, and 9.8% in Mongolia, among others. The share is 2% or less in 10 of 31 Asian countries. On average, poorer countries allocate lower proportions of GDP for social protection. In the US, the share is 9%; in Japan, 16%; and in the European Union, it reaches 19%. Moreover, given the inability to accurately target the poor when needed, the effectiveness of existing schemes in developing countries is questionable.

One recent study (Jha, Kotwal, and Ramaswami, forthcoming) reviews existing social safety net schemes in four developing Asian countries—Bangladesh, India, Indonesia, and the Philippines (Box 3.2). Four major categories of safety net programs were examined: (i) consumer food price subsidies, (ii) food-for-work programs, (iii) feeding programs, and (iv) cash transfers. The study found that the subsidized food programs in all four countries had high rates of both exclusion error (omitting households who qualify for inclusion) and inclusion error (providing assistance to households outside the criteria for inclusion). The study also found regional and ethnic biases in allocation schemes. There are practical problems in identifying qualifying households, as well as simple corruption. The sale of subsidized grain is apparently widespread, but this is not necessarily a problem if the sellers are themselves poor recipients of the grain, who sell it to obtain other commodities

Box 3.2: Social Safety Nets and Food Programs in Selected Developing Asian Countries

Bangladesh

Bangladesh's food safety net program has moved from its colonial system, which involved obtaining supplies and distributing them to consumers in rationed quantities and at subsidized prices, to a more targeted approach that has been in use since the early 1990s. These include in-kind wages for manual labor in public works (Food-for-Work and Test Relief). Other major food transfer safety nets are the Vulnerable Group Development Program—targeting poor women—and feeding programs like the Vulnerable Group Feeding Program and a primary school feeding program. Bangladesh likewise has cash-based social programs such as the Primary Education Stipend Program and the Rural Maintenance Program, with the latter targeting women as well.

India

In India, the central and state governments jointly run a marketing channel called the Public Distribution System (PDS) devoted solely to the distribution of subsidized food grain. This involves a network of private retailers called "Fair Price Shops" that distribute subsidized grains. These Fair Price Shops sell grain below market prices to consumers holding "ration cards," each subject to a quota. Since 1997, subsidies are targeted depending on a household's classification as "above poverty line," "below poverty line," or "poorest of the poor" by the Antayodaya Anna Yojana Program. The program cost is shouldered by the central government, except in cases where state governments cover beneficiaries in excess of central government estimates. Apart from the subsidy, India uses a cash transfer scheme—the National Rural Employment Guarantee Act—in which cash is distributed as wages from public works employment. Another cash transfer program targets those over 65 years old who are classified as below the poverty line.

Indonesia

Indonesia's major safety net programs are its Raskin rice subsidy program; a program providing free inpatient and outpatient care to households at primary health centers and hospitals; and a nonrecurrent cash transfer scheme, Bantuan Langsung Tunai (Direct Cash Assistance [BLT]), used in 2005 and 2008 to help households cope with fuel price increases due to fuel subsidy cuts. Other cash transfers exist in smaller social assistance programs targeting the poor, elderly, persons with disabilities, and youth. One is a conditional cash transfer scheme based on health and education-related conditionalities for household mothers and their school-aged children.

Philippines

The Philippines' rice price subsidy, run by the National Food Authority (NFA), is the largest food program in the country. Almost 90% of the rice under this program is sourced from external markets. During the food, fuel, and financial crises in 2008, when there were over 60 social programs in the country, the NFA subsidy accounted for 70% of the total social protection budget. While the rice price subsidy is largely untargeted—except in 2008, when only low-income households in Metro Manila could purchase subsidized rice—it is accompanied by smaller programs like the Tindahan Natin (Our Store) Program geared toward distributing food supplies to areas determined by a Food Insecurity and Vulnerability Information Mapping System. Among the many other social assistance programs are school feeding programs, where children attending accredited schools receive 1 kilogram (kg) of rice per day—and in selected schools, are provided breakfast. However, most work now is on the government's newest and fast-expanding centerpiece program—a conditional cash transfer scheme (originally the Pantawid Pamilyang Pilipino (Filipino Family Assistance) Program [4Ps]). Begun in 2007 with a pilot group of 6,000 households, the program covered 2.3 million households by 2011, with a target of 3 million households by 2012. To qualify, households must: (i) be located in poor areas; (ii) be classified as poor through a proxy means test; (iii) have either a pregnant mother or at least one child aged 0–14; and (iv) meet conditions relating to education and health, such as 85% school attendance, health clinic visits, and de-worming for children.

Source: Jha, S., A. Kotwal, and B. Ramaswami. Forthcoming. The Role of Social Safety Nets and Food Programs. *ADB Economics Working Paper*. Manila: ADB.

or higher quality food. It becomes a serious problem, however, if the sellers are public officials charged with distributing subsidized grain.

In India, the Public Distribution System (PDS) for subsidized access to grains is said to have exclusion and inclusion errors of 70%. Similar rates of inclusion error are reported for Indonesia's Raskin (Rice for the Poor) program and the Philippines' subsidized food program under its National Food Authority (NFA), though exclusion errors are somewhat lower—29% in Indonesia and 52% in the Philippines.

These data do not necessarily show that existing programs are counterproductive, because at least some of the benefits do reach the intended beneficiaries. Nevertheless, the associated wastage and corruption are major issues, which raise the question of whether program objectives should be pursued in other ways. Throughout Asia, the fiscal stimulus and reduced government revenues that followed the 2008–2009 global financial crisis increased the urgency of finding better ways of using public money.

IV. Availability of Food: Competing Demands for Resources, Productivity, and Agricultural Research

Boosting food production to meet ever-increasing demand often comes at the expense of dwindling natural resources. With these growing pressures, the only sensible way would be to enhance agricultural productivity—higher yields with fewer resources—and to use food more efficiently, which would include improving product delivery and minimizing waste.

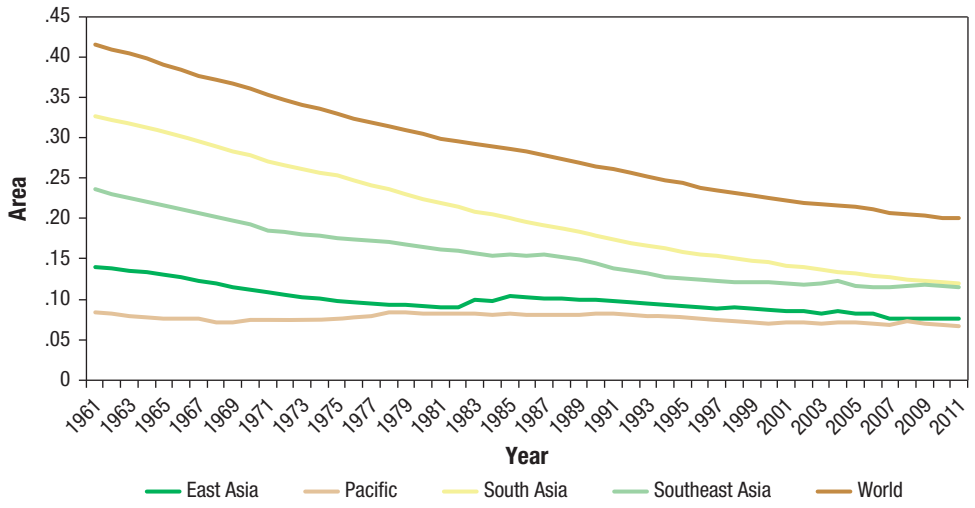
Competing Demands for Land, Water, and Energy

The ongoing structural transformation increasingly constrains the complex nexus of the availability and sustainability of natural resources in providing food security. Trends in population, economic growth, industrialization, urbanization, and changing dietary patterns are already tightening the grip on scarce natural resources. Growth in food demand is expected to accelerate over the next few decades as population and economic growth expand in developing countries. The more affluent will demand more protein-rich and resource-demanding products—not just meat and dairy products, but also vegetables and sugars. All these require far more water and energy per calorie produced than cereals. Increased competition for land, water, and energy is a threat to sustainable agriculture and global food systems.

Total arable land declined from 0.36 hectares per capita (ha/capita) in 1970 to 0.20 ha/capita in 2011 (Figure 4.1). According to one estimate (Alexandratos and Bruinsma 2012), arable land is projected to drop further to 0.18 ha/capita by 2050. Total arable land in East and South Asia went down from 0.24 ha/capita in 1961–1963 to 0.13 ha/capita in 2005–2007.[10] It is expected to reach just 0.10 ha/capita by 2050. The decline is more evident in South Asia, where arable land per capita fell from 0.33 ha/capita in 1961–1963 to 0.14 ha/capita in 2005–2007—and is expected shrink further to less than 0.10 ha/capita by 2050. Estimates for East Asia show arable land per capita fell from 0.19 ha/capita in 1961–1963 to 0.12 ha/capita in 2005–2007—and is also expected to fall further to 0.11 ha/capita by 2030, remaining steady through 2050 mostly due to declining population.

[10] The composition of East Asia and South Asia in this estimate is different from that used in Figure 4.1. Alexandratos and Bruinsma (2012) define East Asia to include Cambodia; the PRC; Hong Kong, China; Indonesia; the Democratic People's Republic of Korea; the Republic of Korea; the Lao PDR; Malaysia; Mongolia; Myanmar; the Philippines; Thailand; and Viet Nam. South Asia includes Bangladesh, India, Nepal, Pakistan, and Sri Lanka.

Figure 4.1: **Arable Land, 1961–2011**
(ha/capita)



ha = hectare.

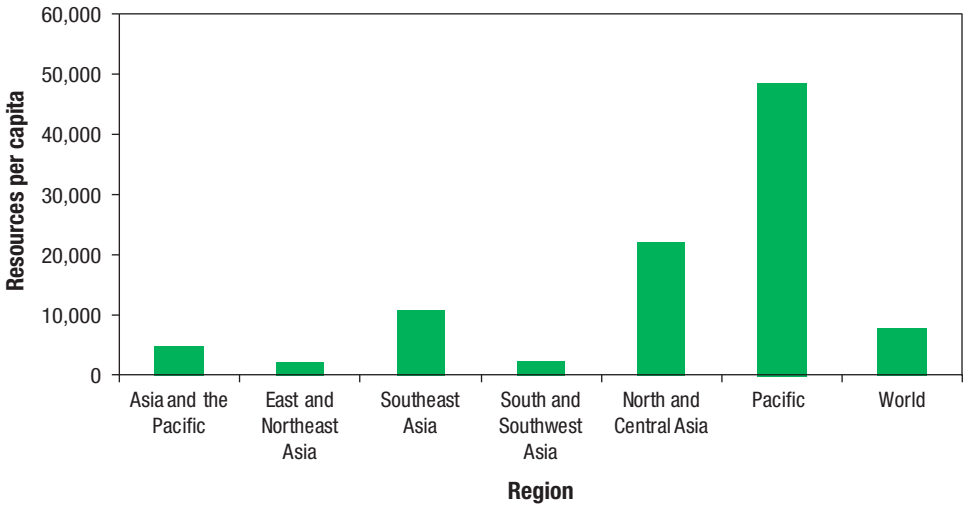
Note: Refer to Appendix A for a list of economies in each region.

Sources: ADB estimates based on data on arable land, http://faostat.fao.org/site/377/default.aspx#ancor (accessed 7 May 2013), and on population, http://faostat.fao.org/site/550/default.aspx#ancor (accessed 7 May 2013), both from FAOSTAT.

Water resources are increasingly strained worldwide, with agriculture consuming about 80% of the world's "blue water" from bodies of water and aquifers (Rosegrant, Cai, and Cline 2002). Moreover, global water distribution is uneven relative to population, being relatively scarce in more populous regions in Asia and the Pacific (Figure 4.2). Water resource availability in Asia ranges from less than 2,500 cubic meters per capita per year (m^3/capita/year) in densely populated Northeast, South, and Southwest Asia, to about 50,000 m^3/capita/year in the Pacific. And this is also dropping gradually due to population growth. Across Asia, between 60% and 90% of water consumption is for agriculture (Figure 4.3). But the region's growing population and rapid urbanization are intensifying competition for water resources. Water consumption in the region for households and industries increased from 13% to 22% between 1992 and 2002 (UN Economic and Social Commission for Asia and the Pacific [UNESCAP] 2011). Meanwhile, global agricultural water consumption (including both rainfed and irrigated) is projected to increase by about 19% by 2050 (UN Educational, Scientific and Cultural Organization [UNESCO] 2012). Asia and the Pacific would need an additional 2.4 billion cubic meters (m^3) of water per day to provide each consumer with 1,800 calories per day by 2050 (UNESCO 2012).

Expanding cultivated lands is no longer an option for food production growth in nearly all of Asia and the Pacific. However, there is much room for farmers to produce more with currently available resources. For example, where irrigation is available in Southeast Asia, the average maximum rice yield is estimated at 8.5 tons per hectare. However, actual yields average only 60% of this (Godfray et al. 2010). Similar yield gaps exist for rainfed wheat in Central Asia. Increasingly constrained water resources for agriculture are aggravated

Figure 4.2: **Renewable Water Resources, 2010** (m^3/capita/year)



m^3 = cubic meter.

Note: Aggregation is based on the UN Economic and Social Commission for Asia and the Pacific (UNESCAP) regional groupings, which are different from those in Appendix A: East and Northeast Asia (called "East Asia" in Appendix A) includes the Macau Special Administrative Region of the People's Republic of China (Macau SAR); Southeast Asia includes Timor-Leste; South and Southwest Asia (called "South Asia" in Appendix A) includes Iran and Turkey; North and Central Asia (called "Central and West Asia" in Appendix A) includes the Russian Federation; and Pacific includes American Samoa, French Polynesia, Guam, New Caledonia, Niue, the Northern Mariana Islands, and Tuvalu in addition to the economies listed in Appendix A.

Source: UNESCAP. 2011. Statistical Yearbook for Asia and the Pacific 2011. http://www.unescap.org/stat/data/syb2012/ (accessed 29 May 2013).

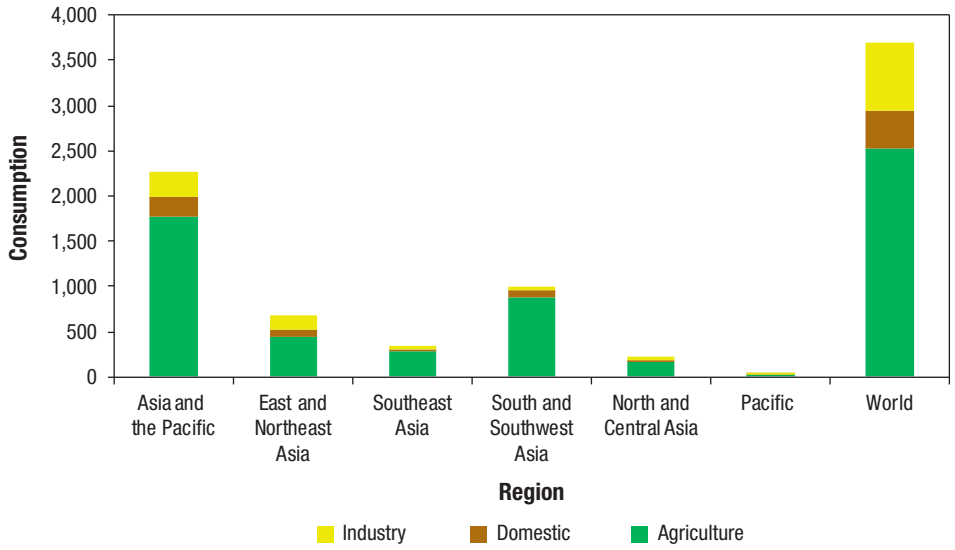
by energy prices, which have risen significantly in recent years. High energy prices hurt food production through the use of fertilizers and fuels for tillage, planting, harvesting, and transportation. Costs of extracting water and providing irrigation also rise. More generally, high energy prices raise the costs of inputs, production, transportation, and marketing—all affecting agricultural output and food prices.

Agricultural Productivity

With the majority of Asia's poor—and the world's poor, generally—living in rural areas, agriculture can play a powerful role in reducing poverty. Not only does agricultural productivity growth increase the availability of food, it also increases the incomes of the rural poor—and thus enhances access to food and provides better food security. For example, studies (Suwannarat 2011; Warr 2005, 2008) show that agricultural productivity growth significantly contributed to poverty reduction in selected Association of Southeast Asian Nations (ASEAN) economies (Box 4.1).

Better agricultural productivity can come in either or both of two ways: (i) through improved productivity at the farm level, reducing the cost of producing food and thus reducing its

Figure 4.3: **Water Consumption in Asia and the Pacific** (billion m^3)



m^3 = cubic meter.

Note: Aggregation is based on the UNESCAP regional groupings, which are different from those in Appendix A: East and Northeast Asia (called "East Asia" in Appendix A) includes the Macau SAR of the PRC; Southeast Asia includes Timor-Leste; South and Southwest Asia (called "South Asia" in Appendix A) includes Iran and Turkey; North and Central Asia (called "Central and West Asia" in Appendix A) includes the Russian Federation; and Pacific includes American Samoa, French Polynesia, Guam, New Caledonia, Niue, the Northern Mariana Islands, and Tuvalu in addition to the economies listed in Appendix A.

Source: UNESCAP. 2013. *Building Resilience to Natural Disasters and Major Economic Crises*. Bangkok: UNESCAP. http://www.unescap.org/idd/Pubs/ThemeStudy2013/ThemeStudy2013-full.pdf

price to the wholesale market; and/or (ii) through enhanced postharvest productivity—more efficient marketing between producers and retailers, and better refrigeration and public transport infrastructure, for example. Reducing losses for all those involved in the supply chain can improve farm and marketing profitability, while simultaneously allowing for more food to be available for consumers at more affordable prices.

Productivity at the Farm Level

Annual cereal production in Asia and the Pacific has continued to grow—from about 350 million tons in the early 1960s to about 1.15 billion tons in the latter part of the first decade of the 2000s. The region's share in total cereal production worldwide went up from 37.0% to 47.5% over the same period. However, the pace of this production growth has been declining, slowing precipitously during the 1990s, and then picking up slightly in the 2000s (Figure 4.4). The decline in cereal production growth has been largely due to a decline in yield, as the gains from the Green Revolution waned by the 1990s. A similar pattern is also seen in the production, yield, and area planted for rice and wheat (Figure 4.4). The growth in area planted to rice and wheat has declined since the 1960s—from about 1.4% annually for both crops, to 0.6% for rice and 1% for wheat in 2002–2011. Yield growth also declined over the same period, from about 2.5% to 1.5% for rice, and 4.9% to 1.1% for

Box 4.1: Agricultural Productivity Growth in Thailand

In Thailand, 86% of the population below the government's poverty line lives in rural areas. Most derive their incomes from agriculture. Using data on rural and urban poverty incidence in each of four regions—Central, South, North, and Northeast Thailand—from 1988 to 2010 at 2-year intervals, from the government's biannual Socio-economic Survey, Warr (2013) estimated the impact of agricultural productivity growth on poverty incidence (Table B4.1). Data on agricultural productivity growth were estimated on an annual basis for each region covering 1986–2010, along with annual data on food prices relative to the consumer price index (CPI) over the same period.

The estimated results suggest that greater agricultural productivity reduced both rural and urban poverty incidence. While this seems obvious for the rural poor, for the urban poor it may indicate the close economic links between the urban poor and their rural families. Many urban poor work part-time on the family farm, returning to the cities when demand for agricultural work is lowest. The rural and urban poor are also linked through remittance flows.

Table B4.1: Agricultural Productivity Growth and Poverty Incidence in Thailand

Item	Rural	Urban
Annual change in TFP (–1)	–16.549***	–10.840**
Annual change in food price/CPI	0.403***	0.194
North	0.605	–0.822
Northeast	–1.179	–0.974
South	–0.550	–0.236
Dummy for 1996–1998	2.788**	1.351
Dummy for 1998–2000	7.858**	5.346***
Constant	–3.340***	–2.055***

CPI = consumer price index, TFP = total factor productivity.

*** = significant at the 1% level of significance; ** = significant at the 5% level of significance; * = significant at the 10% level of significance.

Note: Poverty incidence is the dependent variable.

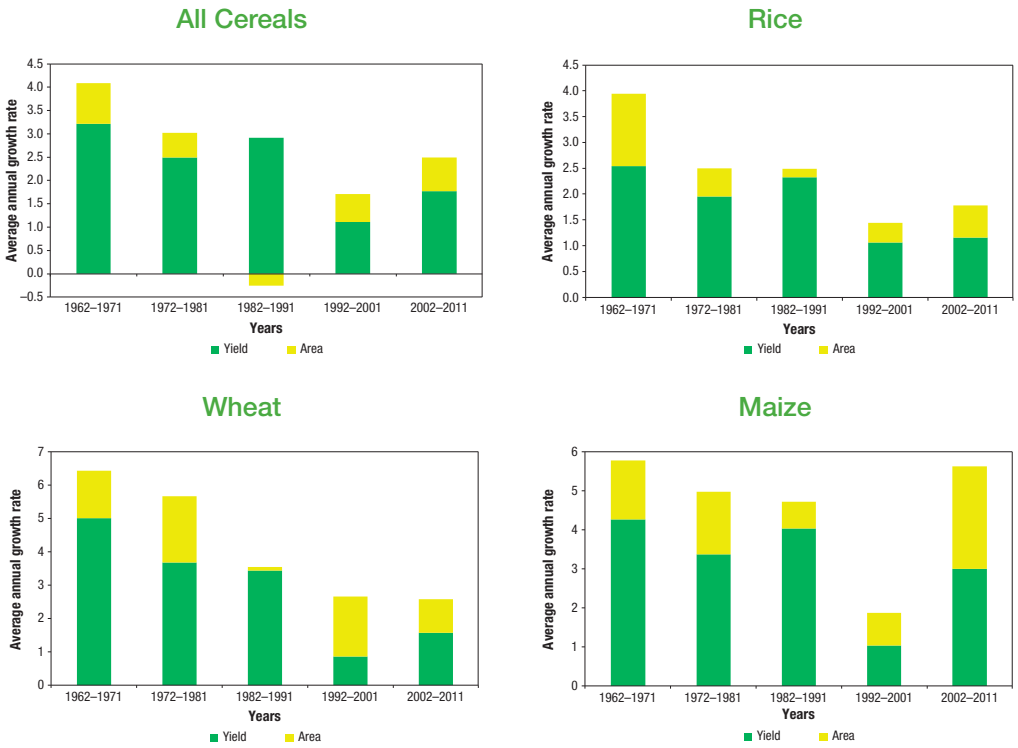
Source: See box source.

Source: Warr, P. 2013. Agricultural Productivity and Poverty Reduction in Thailand. Mimeo. Australian National University.

wheat. The production growth of maize also declined by less than half in the 1990s, as yield growth declined sharply (Figure 4.4). However, growth in maize production has more than tripled in the last decade—as the result of an increase both in area planted and in yield. Increasing demand for maize as important livestock feed may have been a driver behind the recent production increase of maize in Asia and the Pacific.

The long-term rates and determinants of productivity growth in Asian agriculture have been examined (Sombilla, Mapa, and Piza, forthcoming), with some encouraging preliminary evidence of improvement in total factor productivity (TFP). TFP in rice production in the different subregions of Asia increased from the 1980s to the first decade of the 2000s (Figure 4.5). TFP in rice production in the last decade was 2.2% in East Asia, 3.5% in South Asia, and 3.1% in Southeast Asia. Considering the declining yield growth, the productivity of factors of production other than land must have been increasing more rapidly than the

Figure 4.4: **Yield and Area Growth Trends for Cereals in Asia and the Pacific, 1962–2011**
(%)



Notes:
1. All cereals include major cereals such as maize, rice, and wheat, as well as other cereals such as barley, buckwheat, canary seed, fonio, millet, mixed grain, oats, quinoa, rye, sorghum, and triticale.
2. Refer to Appendix A for a list of economies in Asia and the Pacific.

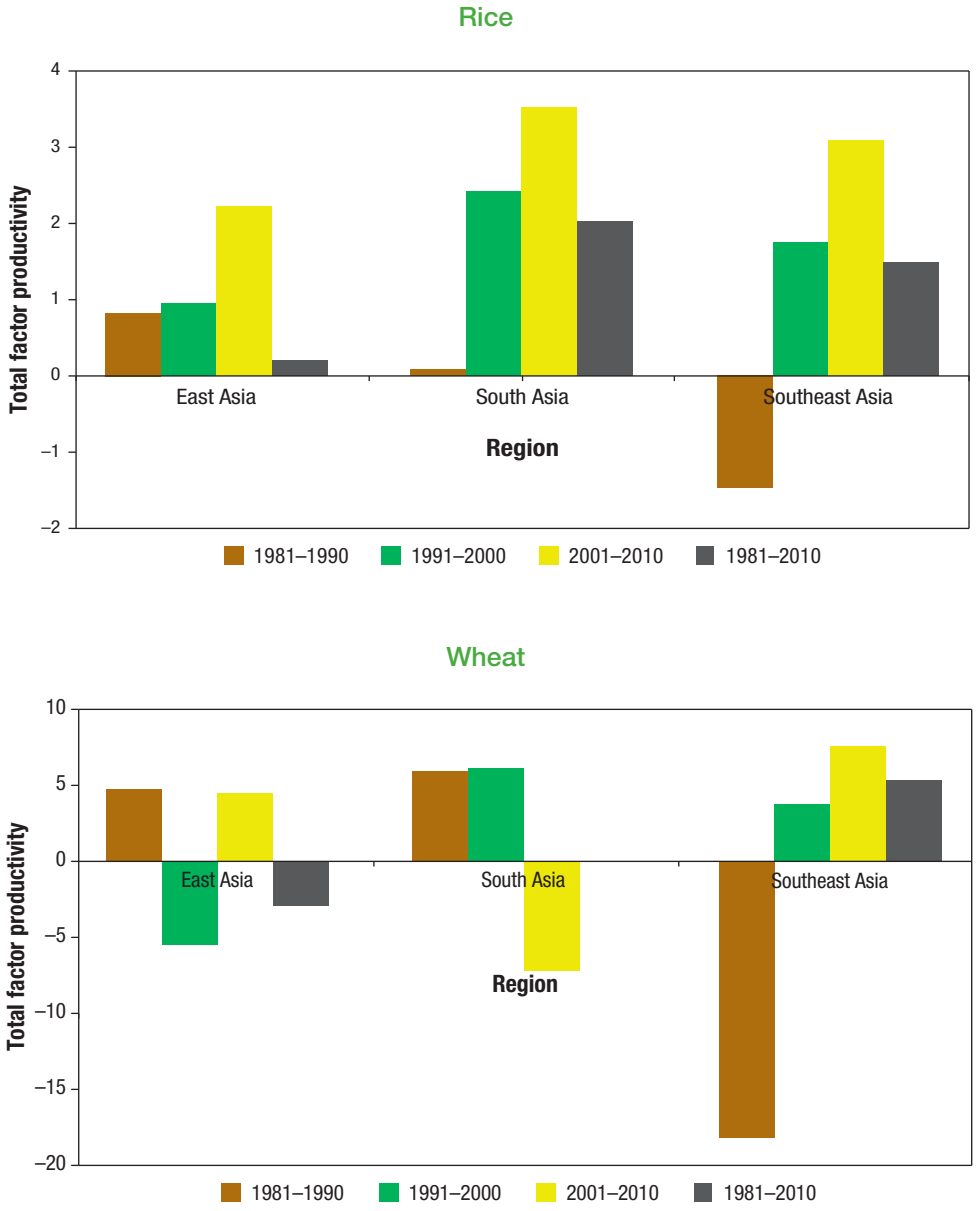
Source: ADB estimates based on production and harvested area data from the FAOSTAT, http://faostat.fao.org/site/567/default.aspx#ancor (accessed 7 May 2013).

reported TFP—which is a cost-share weighted average of the growth rates of productivity of the individual factors. This must mean that labor productivity, in particular, increased through mechanization. In the case of wheat, the data indicate a moderate decline in TFP from the 1980s to the 2000s (Figure 4.5) in some subregions of Asia.[11]

There are three main threats to sustaining productivity growth: (i) waning gains from Green Revolution technology; (ii) maintaining soil health as multiple cropping expands; and (iii) battling new strains of pests and disease, some resistant to existing chemical controls. Soil erosion, salinization, water pollution, and excessive use from underground sources also threaten continued improvement in TFP. Small farms have difficulty raising productivity through mechanization, despite the emergence of machine rentals in some markets.

11 Wheat production in Southeast Asia is small, done primarily in Myanmar and Thailand, and only since the 1980s. Production growth drastically slowed during 1981–1990, picking up in 2001–2010, which explains the relatively high TFP estimate for the most recent period.

Figure 4.5: **Total Factor Productivity in Major Cereals, 1981–2010**
(%)



Notes:
1. For rice, East Asia includes the People's Republic of China (PRC) and Mongolia; Southeast Asia includes Cambodia, Indonesia, the Lao People's Democratic Republic (Lao PDR), Malaysia, Myanmar, the Philippines, Thailand, and Viet Nam; and South Asia includes Bangladesh, India, Nepal, Pakistan, and Sri Lanka.
2. For wheat, East Asia includes the PRC and Mongolia; Southeast Asia includes Myanmar and Thailand; and South Asia includes Bangladesh, India, Nepal, Pakistan, and Sri Lanka.

Source: Sombilla, M., D. Mapa, and S. Piza. Forthcoming. Overcoming Critical Constraints to Sustaining Agricultural Productivity Growth in Asia and Pacific. *ADB Economics Working Paper*. Manila: ADB.

Tenure arrangements affect land rights and reduce incentives for farmers to invest in improving productivity. There have been reforms in providing legal rights to land, but these have not been rapid enough in many Asian countries to show productivity gains. Credit markets remain insufficient, partly as a result of poorly defined land rights, limiting potential collateral for loans.

Postharvest Productivity

Agricultural productivity is determined both on and off the farm. Estimates show roughly half of the final consumer price of food in Asia emanates on the farm, while the other half is accounted for by postfarm costs. Of course, proportions vary considerably by locality and commodity. However, both farm and off-farm productivity are important for food security—together they determine the cost of food to the final consumer. Despite off-farm productivity being roughly equal to farm level productivity, it has received far less attention.

All three segments of the overall food value chain—upstream (farming and input supply), midstream (processing and wholesale), and downstream (retail)—are undergoing significant transformation. Overall, lowering off-farm costs benefits both farmers and consumers. The process is driven primarily by the private sector, but public policy has an important role to play. First, monopolies must be prevented by promoting competition. Reducing entry barriers to new firms effectively prevents exploitative monopolies from developing. Second, much private sector activity is dependent on public infrastructure. Aside from farm-to-market infrastructure, reliable power is needed for cold storage, for example. In larger, mostly urban markets, liberalizing foreign direct investment (FDI) allows more cost-efficient food processing and retailing through supermarkets.

How food moves through the supply chain is changing rapidly—especially the way it is marketed. The food value and supply chain revolution taking shape in India is an example of this transformation (Box 4.2)—one that has already taken root in the PRC.

Minimizing food loss and waste also enhances food availability. The FAO estimates roughly one-third of food produced for human consumption globally is lost or wasted (Gustavsson et al. 2011). Food losses occur throughout the supply chain—from farm production to household consumption. Food losses and waste are generally much higher in advanced economies than in developing countries. For example, per capita food loss in Europe and North America is 280–300 kilograms per year (kg/year), while it is 120–170 kg/year in Sub-Saharan Africa, South Asia, and Southeast Asia. However, when compared against the smaller total per capita production in developing countries, the ratio of food loss to total food production in developing countries is no less than in advanced economies. For example, the total per capita food production in Sub-Saharan Africa and South and Southeast Asia is about 460 kg/year compared with about 900 kg/year in Europe and North America. In other words, approximately one-third of production is lost.

In medium- and high-income countries, much food is wasted at the consumption stage—that is, it is discarded even if it is still edible. Figure 4.6 shows loss and waste in the food supply system for cereals. In developing countries, food loss during postharvest and processing accounts for more than 40% of total losses. Although food waste by consumers is relatively limited, significant food loss occurs during production and postharvest handling

Box 4.2: The Rice Value Chain Transformation in Bangladesh and India

Rice value chains can be grouped into four types, varying in terms of geographical length or the physical distance from farm to retailer, and by intermediational length or the number of steps from farm to retailer measured in the number of agents intermediating between them. These four types of value chains are as follows:

1. **Traditional rice value chain.** Contained in the rural areas, this chain is geographically and intermediationally short, and consists of the local supply chain of paddy grown by the farmer, which is dehusked in a local village mill and consumed by the farm household or sold to the local village market for local consumption.
2. **Rural–urban traditional rice value chain.** This chain is geographically long and intermediationally long, and features the sale of paddy to local brokers or village traders, who sell it as paddy or have it milled in village mills that sell it to rural wholesale markets, where wholesalers from the cities buy it to sell to semi-wholesalers or traditional retailers.
3. **Transitional rice value chain.** This chain is geographically long and intermediationally medium, and entails the rice farmer selling paddy directly to mills. The mills then sell the rice to city wholesale market traders—or they sell the paddy to rural or city wholesale market traders, who have it milled and then sell the rice in the city wholesale market. Traditional retailers buy the rice directly at the city wholesale market.
4. **Modern rice value chain.** This value chain is geographically long and intermediationally short, with the farmer selling paddy directly to mills that in turn sell the rice directly to urban wholesale markets or directly to supermarkets and traditional urban retailers.

Using a survey of thousands of farmers, millers, and retailers, a study (Reardon et al., forthcoming) was conducted by the International Food Policy Research Institute (IFPRI) in 2009–2010 to provide insight into South Asia's rice value chains. The study—which covered the rice value chain from Noagoan to Dhaka in Bangladesh, and from Shahjahanpur to New Delhi in India—suggested that rice value chains are recasting their traditional image, with changes involving significant modernization in retail markets. These changes signify a "quiet revolution" in traditional value chains in South Asia for two reasons. First, the arrival of foreign direct investment (FDI) in processing and changes in world food trading systems that are transforming traditional staples chains tend to take place in the midstream—among traders and in rice mills. These midstream changes mirror the more visible downstream modernization in that they involve consolidation, and technological and organizational changes in the segments. Second, the midstream changes are "quiet" because they are grassroots in nature and are as yet generally unrecognized, and their importance underappreciated, especially in policy circles.

Rice value chains in both countries appear to be shifting from the traditional to an intermediate stage, with a decline in the role of the traditional rural middleman or village trader, and the rise of direct sales from farmers to mills and wholesale markets. In Bangladesh, the rural–urban traditional value chain still dominates, but the transitional value chain is emerging quickly, with direct sales to mills. In India, on the other hand, the transitional value chain dominates the market, with the continued use of village traders and rural wholesale markets upstream, but with the direct sale from mills to urban traders downstream. The most traditional value chain no longer has a significant presence in either of these countries. The study found that the role of the village trader had shrunk, controlling only 7% of farms and sales in Bangladesh, and 38% of farms and 18% of sales in India. Second, the role of the wholesaler—mainly at the wholesale market but also at the mill—was becoming far greater due to direct purchase from the farmer: in both Bangladesh and India, farmers sold about 63% of their paddy directly to wholesalers. Third, incipiently in Bangladesh but not yet in India, farmers were bypassing middlemen and selling directly to mills: of all paddy rice sold in Bangladesh, 30% was sold directly to mills; in India, that figure was 5%. The lower percentage in India is probably due to the Agricultural Produce Marketing Act that continues to be enforced in Uttar Pradesh, limiting market transformation.

continued on next page

Box 4.2 *continued*

Likewise, there have been significant structural and organizational changes in the mill segment. Rice milling is becoming more concentrated in the medium-sized and large mills, with a rapid decline in small village mills, especially in India. Milling technology in both countries has also been changing toward semi-automatic and automatic mills. Private milling and trading firms have made large investments in capacity expansion, new technology, logistics, and services to farmers. The survey showed evidence of disintermediation upstream, with the traditional role of the village trader diminishing as wholesale markets sourced paddy directly from farmers, while mills increased direct sourcing from farmers. Moreover, disintermediation was also evident downstream, with mills selling directly to wholesale markets in the big cities. Meanwhile, traditional rice retail has been evolving in ways that point toward greater quality differentiation, packaging, and brand development, more so in Bangladesh than in India. Given these incipient changes, it is likely that branding and the resulting traceability will be significant factors in the development of rice markets in urban Asia, encouraging continued consolidation in the mill and trading sectors.

While much policy debate centers on direct government operations in food value chains, such operations in the rice value chain in the areas studied were in general quite small, except for the Government of India's purchases from mills. The implication is that the great majority of the activity in rice value chains is based on private sector actions, whether traditional or modern. Thus, a great deal of emphasis should be placed on enabling the private sector's involvement and providing it with the incentives to assist in attaining national food security objectives. That said, the indirect roles played by the government have been important in enabling change by providing incentives for transformation through investments in infrastructure and research, including extension services.

Government subsidies were shown to have important effects. Subsidies for rice seeds, fertilizer purchases, and mill upgrading appear to have encouraged the use of and investment in these items, which have played important roles in transforming the value chains. However, the survey also showed that the subsidies did not always go to the target beneficiaries. A key policy implication is that if large subsidies are distributed, great care should be taken to ensure that they are properly targeted and delivered.

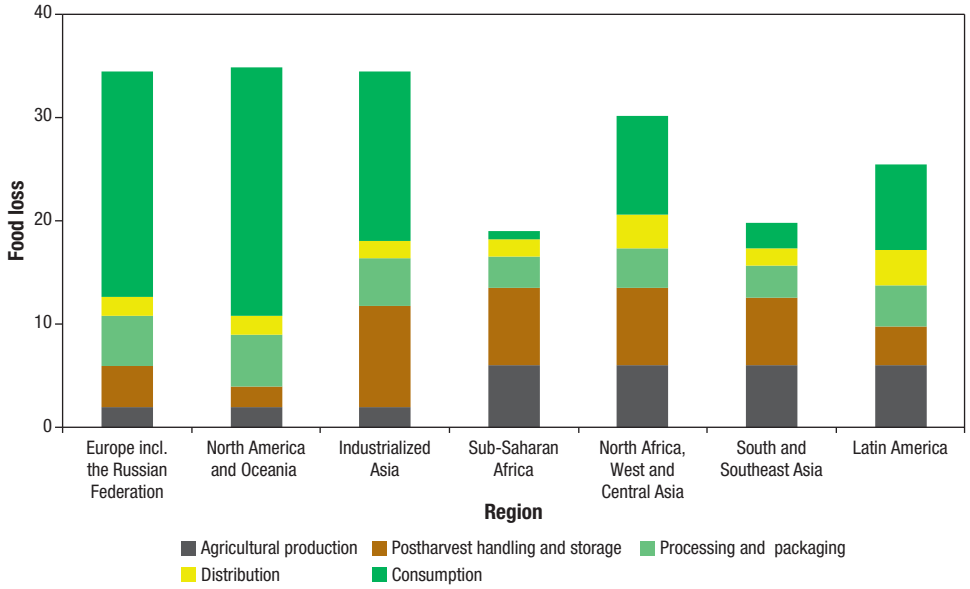
Source: Reardon, T., B. Minten, K. Chen, and L. Adriano. Forthcoming. The Transformation of Rice Value Chains in Bangladesh and India: Implications for Food Security. *ADB Economics Working Paper*. Manila: ADB.

and storage. This is true across different types of food in the developing countries of South and Southeast Asia (Figure 4.7). The quality of postharvest infrastructure will likely become far more important in developing countries as dietary composition in these countries shifts from cereals and grains to fruits and vegetables, which perish quickly and have limited shelf life—and to animal-sourced food such as meat, which requires special care to meet sanitary and phytosanitary requirements.

Agricultural Research

Agricultural research is critical to raising productivity. It also helps find innovative ways to adapt to changes in agricultural environment due to climate change. Agricultural research conducted by individual developing countries differs in nature from fundamental research conducted by international institutions, including universities. While fundamental agricultural research takes long before it bears fruit, adaptive research needed most in developing countries pays off much more quickly. Its value is primarily

Figure 4.6: **Food Losses Within the Food Supply System in Cereals, by Region**
(%)



incl. = including.

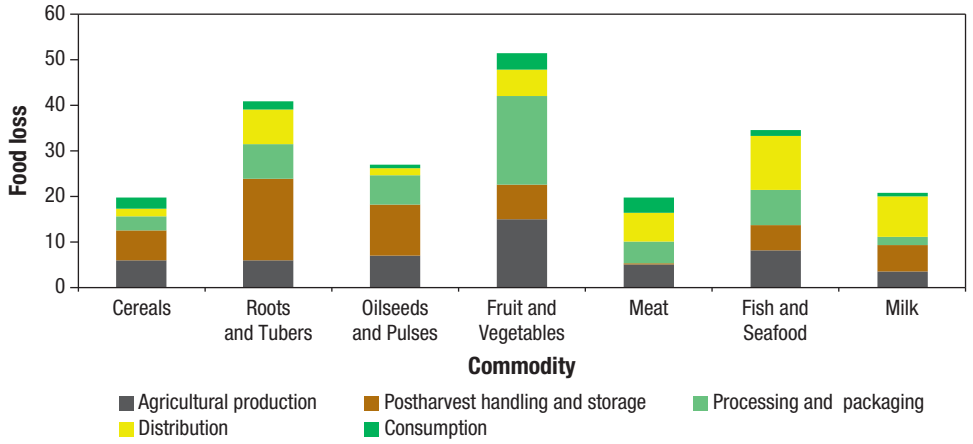
Notes:
1. "Food" waste or loss is measured only for products for human consumption, excluding inedible feed and product parts. Therefore, food originally meant for human consumption that drops out of the human food chain is considered food loss or waste, even if directed to nonfood uses such as feed or bioenergy (Gustavsson et al. 2011).
2. Regional groupings are as defined by Gustavsson et al. (2011).

Source: Gustavsson, J., C. Cederberg, U. Sonesson, R. van Otterdijk, and A. Meybeck. 2011. *Global Food Losses and Food Waste: Extent Causes and Prevention*. Study conducted for the International Congress SAVE FOOD! at Interpack Düsseldorf, Germany. Rome: FAO. http://www.fao.org/docrep/014/mb060e/mb060e00.pdf

local as its findings may not be applicable to other regions. For this reason, these two forms of agricultural research—fundamental and adaptive—are complements rather than substitutes.

Relative to the world as a whole, Asia's commitment to agricultural research as measured by public agricultural research and development (R&D) intensity—the ratio of public agricultural R&D spending to agricultural GDP—has been low (Figure 4.8). However, the region's spending on R&D has increased rapidly since the 1990s. This is reflected in Asia and the Pacific's growing share in global public agricultural R&D spending (Figure 4.9)—undoubtedly contributing to Asia's agricultural productivity growth. It is essential that this commitment be maintained, especially in light of the growing pressure on resources and the transformation taking place across Asia and the Pacific.

Figure 4.7: **Food Losses Within the Food Supply System in South and Southeast Asia, by Commodity Group**
(%)



Notes:
1. "Food" waste or loss is measured only for products for human consumption, excluding inedible feed and product parts. Therefore, food originally meant for human consumption that drops out of the human food chain is considered food loss or waste, even if directed to nonfood uses such as feed or bioenergy (Gustavsson et al 2011).
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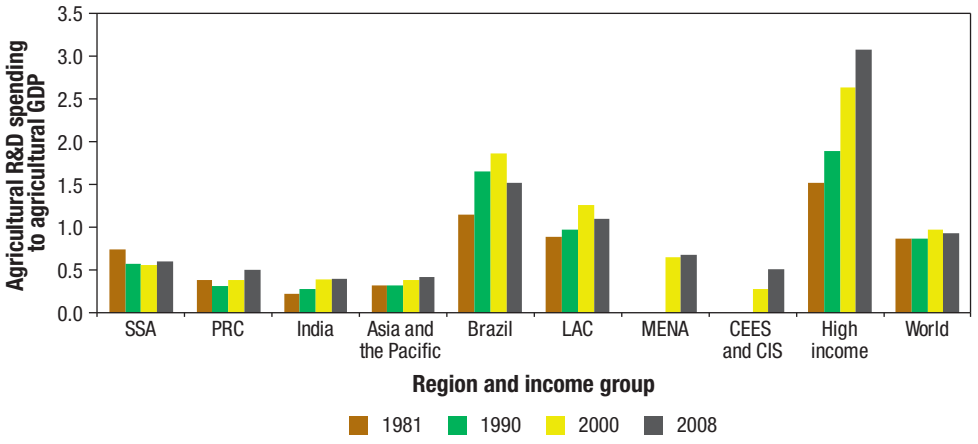
Source: Gustavsson, J., C. Cederberg, U. Sonesson, R. van Otterdijk, and A. Meybeck. 2011. *Global Food Losses and Food Waste: Extent Causes and Prevention*. Study conducted for the International Congress SAVE FOOD! at Interpack Düsseldorf, Germany. Rome: FAO. http://www.fao.org/docrep/014/mb060e/mb060e00.pdf

Figure 4.8: **Public Agricultural Research and Development Intensity, by Region and Income Group**
(%)

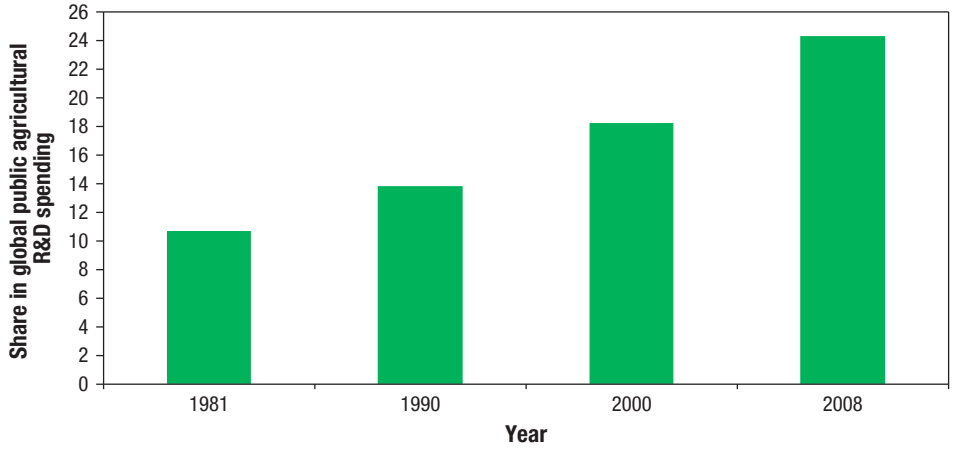


CEES and CIS = Common European Economic Space and Commonwealth of Independent States, PRC = People's Republic of China, GDP = gross domestic product, LAC = Latin America and the Caribbean, MENA = Middle East and Northern Africa, R&D = research and development, SSA = Sub-Saharan Africa.

Note: Regional groupings are as defined by Beintema, N. M., G. J. Stads, K. Fuglie, and P. Heisey. 2012. *ASTI Global Assessment of Agricultural R&D Spending: Developing Countries Accelerate Investment*. Washington, DC and Rome: International Food Policy Research Institute (IFPRI) and Global Forum on Agricultural Research. http://www.ifpri.org/sites/default/files/publications/astiglobalassessment.pdf

Source: Agricultural Science and Technology Indicators (ASTI) database as published in Beintema et al. 2012. http://www.asti.cgiar.org/pdf/GlobalAssessmentDataTables.pdf (accessed 6 May 2013).

Figure 4.9: **Share of Asia and the Pacific in Global Public Agricultural Research and Development Spending, 1981–2008**
(%)



R&D = research and development.

Note: Regional groupings are as defined by Beintema, N.M., G. J. Stads, K. Fuglie, and P. Heisey. 2012. *ASTI Global Assessment of Agricultural R&D Spending: Developing Countries Accelerate Investment*. Washington, DC and Rome: IFPRI and Global Forum on Agricultural Research. http://www.ifpri.org/sites/default/files/publications/astiglobalassessment.pdf

Source: ASTI database as published in Beintema et al. 2012. http://www.asti.cgiar.org/pdf/GlobalAssessmentDataTables.pdf (accessed 6 May 2013).

V. Transportation, Logistics, and International Trade

Transport and Logistics

Transport and communication infrastructure networks not only move goods around a country, but also enhance cross-border trade. Assuming deficit areas exist, infrastructure helps food reach them and prevents any surplus from depressing local prices. The low value-to-bulk ratio of most food products means delivered prices are highly sensitive to changes in logistics costs—important determinants of agricultural and other trade flows (Brooks and Hummels 2010).

Food in Asia and the Pacific is predominantly produced on farms. Farm produce is then transported for processing and packaging, and moved to the store or supermarket warehouse. The entire food supply chain utilizes transportation systems such as roads, railroads, and ports around a network of intermodal hubs. At multiple points during the transport stage, food products may pass through an intermodal hub where it is warehoused and loaded onto another transport mode. When food reaches the store or supermarket warehouse, it is transferred to the wholesale or retail outlet where it is purchased and consumed. The risks and vulnerabilities to food systems can be found along this food supply chain.

Although international trade is important in enhancing food security, domestic trade is far more critical. Rice is an extreme example. Only 4%–5% of the global production of rice is traded in international markets. Farmers' access to markets must be facilitated by investment in rural road construction and maintenance. This will also help in reducing trade costs. Rural residents benefit in three ways. First, transport costs to wholesale markets are often shouldered by smallholders. Thus, better roads raise the profitability for farmers given the same price received from wholesalers. Second, it reduces the costs farmers pay for agricultural inputs and other communities purchased, including food bought outside their own farms. Finally, it improves the chances of resolving local food shortages—as reflected in high prices. Good transport allows food to be moved quickly to deficit areas where prices are higher, eliminating otherwise possible severe shortages.

Adequate agricultural infrastructure is essential for improving food security. Better rural roads, irrigation, electricity grids, marketing, rail transport, and information systems are all part of the infrastructure required. Public investment in infrastructure helps reduce agricultural production and transportation costs, improve marketing capacity, and enhance access to knowledge of new technologies. This simultaneously raises farm earnings.

Several studies have shown the significant role rural infrastructure plays in improving agricultural productivity, especially in developing countries. Poor infrastructure or unreliable

transport constrains productive capital investments and leads to a restriction or reduction of output (Llanto 2012). One study shows that deficiencies in transportation, energy, telecommunications, and related infrastructure result in poorly functioning domestic markets that can undermine growth in agricultural output (Pinstrup-Andersen and Shimokawa 2007).

The lack of good infrastructure—particularly in transporting food—can increase the risk of chronic food insecurity among vulnerable groups. Inadequate infrastructure and the lack of intermodal transportation systems contribute to high transport costs, which are passed on to consumers. This is most severe on the rural poor or those living in remote areas. In addition, inefficient freight transport and bottlenecks delay delivery, increasing waste and reducing both the market and nutrition values of perishable food like fresh vegetables and dairy products.

Integrating different modes of transportation helps the efficiency of national and regional transport networks for food distribution, contributing to food security. Work is being done on finding the least costly intermodal food transport systems to more sustainably link food producers with expanding megacities—for example, using rivers and small ports or quays, small refrigerated food vehicles, side railways that transport people during the day and refrigerated rail carriages at night, warehouses and warehouse receipt systems, franchises, and forward contracts, among others.

Regional infrastructure projects such as trans-ASEAN or other subregional Asian networks also help improve transport links. Specifically, regional initiatives should aim at stimulating investment to foster integrated transport networks covering all communities and employing all modes of transport.

International Trade

By allowing producers to sell internationally and consumers to buy from foreign markets, world trade plays an important role in alleviating food insecurity and in export development. Farmers from exporting countries can enjoy higher incomes—which translate to improved food access, a more nutritious diet, and better health. One study argues that trade can influence food security through several channels (Brooks, Ferrarini, and Go, forthcoming):

(i) International trade helps expand markets. It can help address short-term food insecurity in critical times of domestic droughts, floods, disease, or other disruptions to domestic production. In addition to income from export sales of surplus, farmers benefit from access to a greater variety of—or lower-priced—inputs such as seed, fertilizer, pesticides, and machinery. Trade also expands the range of options for exchanging nonfood products for food, and commodities with different nutritional characteristics from each other.

(ii) Trade can enhance food security through price impact and market reaction. A price differential between markets that is greater than trade and transaction costs signals traders to move products from the lower price market to the higher price market. The extent to which trade can influence food security in this process is closely related to how well markets are integrated. Trade in food or agricultural commodities

can serve to reduce price volatility, increasing predictability for planning by both producers and consumers.

(iii) Positive productivity effects can follow from trade, raising agricultural output and food security. It can also encourage crop diversification. Closed markets may discourage firms from adopting productivity-enhancing technology, because without an outlet for excess production, increased production would only depress prices in local markets (Barrett 2008). Price signals reflecting full economic costs and benefits can also encourage diversification. Farm price support—by making the production of staples artificially more profitable relative to other crops—has prevented farmers from diversifying into higher-value products, which in the longer run would sustain higher incomes.

(iv) Trade influences competition, which can increase food security by reducing rent-seeking opportunities and monopolistic practices, reinforcing the aims of competition policy (Brooks and Evenett 2005). As farmers integrate into higher-value agricultural processing chains, competition can help avert monopsonistic procurement practices by those higher up the chain, preserving higher value for poor farmers.

(v) Trade can indirectly influence food security through its impact on the effectiveness of macroeconomic tools. In developing countries, food typically accounts for a significant share of the CPI, so food imports can lower inflationary expectations, leaving more monetary space. Trade also aids government revenue through tariffs. And when free trade agreements are signed, the depth of integration between markets covered by the agreements can promote trade creation.

(vi) Food imports allow for lower, more sustainable production in environmentally fragile areas. Trade can thus help reduce irreversible environmental degradation in times of short-term stress—thereby promoting longer-term sustainable production.

However, the impact of trade on food security is not always unambiguous. For Asia and the Pacific, rice price volatility and its increase since 2007 are especially worrying. Using panel data for 2001 to 2011, one study offered evidence that international food price volatility is transmitted to Asia's domestic markets, though with a lag (Lee and Park, forthcoming). Earlier studies (such as Headey and Fan 2008) used data prior to the international food price crises of 2007–2008, and concluded otherwise. The global transmission of food price volatility has apparently become stronger.

International markets can create instability in affordable access to food, provoking policy responses that can heighten international price volatility. For example, during the food price surge in 2007–2008, when global prices tripled, both exporting and importing countries attempted to shield domestic consumers from high global prices. Some exporters restricted shipments, while some importers reduced tariffs and increased government purchases. Although the aim in both cases was to stabilize domestic prices, the effects were at least partly offsetting (Martin and Anderson 2012). Both sets of policies reduced domestic prices relative to international prices, but they had reinforcing effects on the international price itself—raising it well above the level it would have reached otherwise.

Thus, on one hand, food imports substitute or complement domestic production; on the other, they make a country more vulnerable to international trade disruptions and coordination failure. Moreover, if a commodity is thinly traded—such as rice, also a staple crop for most Asian countries—a small change in one country's net export position can have a huge impact on international prices. The thinness of the international rice market means the tiny amount of international trade—4%–5% of global production during the 2000s—exacerbates price volatility and limits the ability of trade to buffer the effects of periodic supply disruptions (Gilbert 2011). Others argue that it is not thinness that causes global price volatility, but the opposite: price volatility inhibits rice trade (Clarete, Adriano, and Esteban, forthcoming).

A study of bilateral food trade (Brooks, Ferrarini, and Go, forthcoming) analyzed the vulnerability of food-importing countries to supply distortions by focusing on bilateral trading relationships (Box 5). It captured how much a country's imports of a given commodity are dependent on supply from a particular country or region using a bilateral import penetration index (BIPI), an indicator of food security vulnerability arising from an undiversified import base. The study also developed trade maps for four major staples, showing bilateral trade dependence—and revealing that several countries are central players in all of them. The trade maps show that supply disruptions in these key countries can trigger global food price hikes, and show which importing countries are most likely to be immediately affected. For example, the US is a central player in each of the four staples; thus, any event—such as the 2012 drought in the US—can have implications for food security in countries most dependent on US supply. Similarly, Kazakhstan and the Russian Federation are key suppliers for Central Asia and other former Soviet republics. A high degree of reliance on wheat imports from these two major suppliers leads to a high degree of vulnerability in the event of major supply shocks, such as the droughts in 2010 and 2012.

Box 5: **Food Trade Maps**

To analyze the main aspects of vulnerability to a country's bilateral and multilateral dependence on international food imports, one study computed a bilateral import penetration index (BIPI)[a] to gauge how much any one country depends on another for food imports (Brooks, Ferrarini, and Go, forthcoming).

Food trade maps based on the set of computed BIPI values across country pairs and years highlight the strength of bilateral trade ties and the food security vulnerability of individual importing countries to disruptions in those bilateral trade flows.

The first is the network map for rice (Figure B5.1). The nodes (or circles) represent food-trading countries, whether net importers or exporters. The shade of the nodes represents the degree of the country's dependence on food imports: the darker the shade, the more dependent the country. The size of the node represents market clout or centrality in commodity trade, while the location on the map represents the country's connectedness (so major exporters become hubs). The arrows show the direction of trade from net exporters to net importers, while the thickness of the arrow represents how dependent an importing country is on a specific exporting country (the thicker the line, the more dependent).

As can be seen, major rice exporters such as the People's Republic of China (PRC), India, Pakistan, Thailand, and Viet Nam are important hubs in Asia's rice trade. On the other side,

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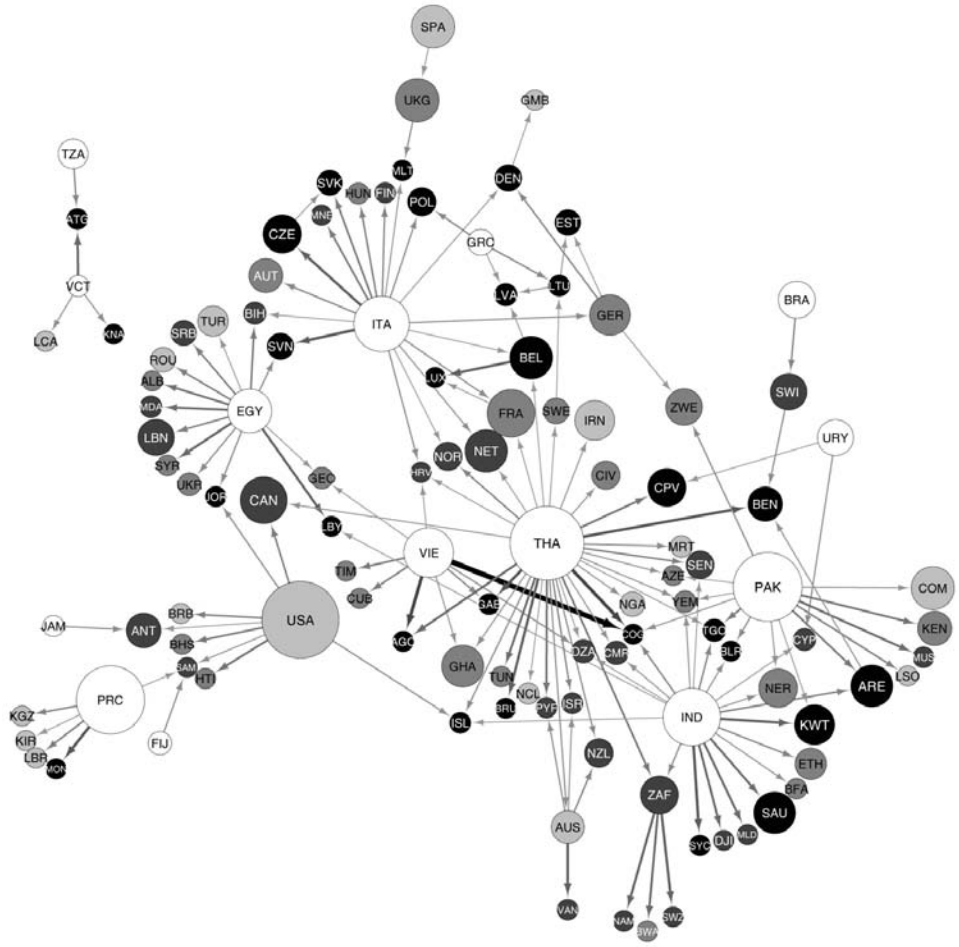
Box 5 *continued*

Figure B5.1: **Rice Trade Map**



Note: Please refer to Appendix B for a list of three-character economy codes.

Source: See box source.

Belgium, Mongolia, and Saudi Arabia are in black nodes, implying strong dependence on rice imports—which makes them vulnerable to potential disruptions to global supply. Different sets of countries cluster around the major rice exporters; for example, Egypt is a hub for Eastern Europe and the Middle East, while Italy services Europe. Also worth noting is the dependence of some importing countries to an exporter: a case in point is Mongolia, which is highly dependent on imports from the PRC, as represented by the thick arrow. This puts Mongolia at greater risk from potential supply disruptions emanating from the PRC. Vulnerabilities can also be passed on. The map's depiction of the network surrounding South Africa is instructive. South Africa's high dependence on India and Thailand for rice imports is passed on as vulnerabilities to Botswana, Namibia, and Swaziland. An interesting finding is that most Asian countries, with the exception of Brunei Darussalam and Mongolia, are only weakly dependent on imports for the bulk of their domestic consumption. Big rice importers in the region, such as Bangladesh, Indonesia,

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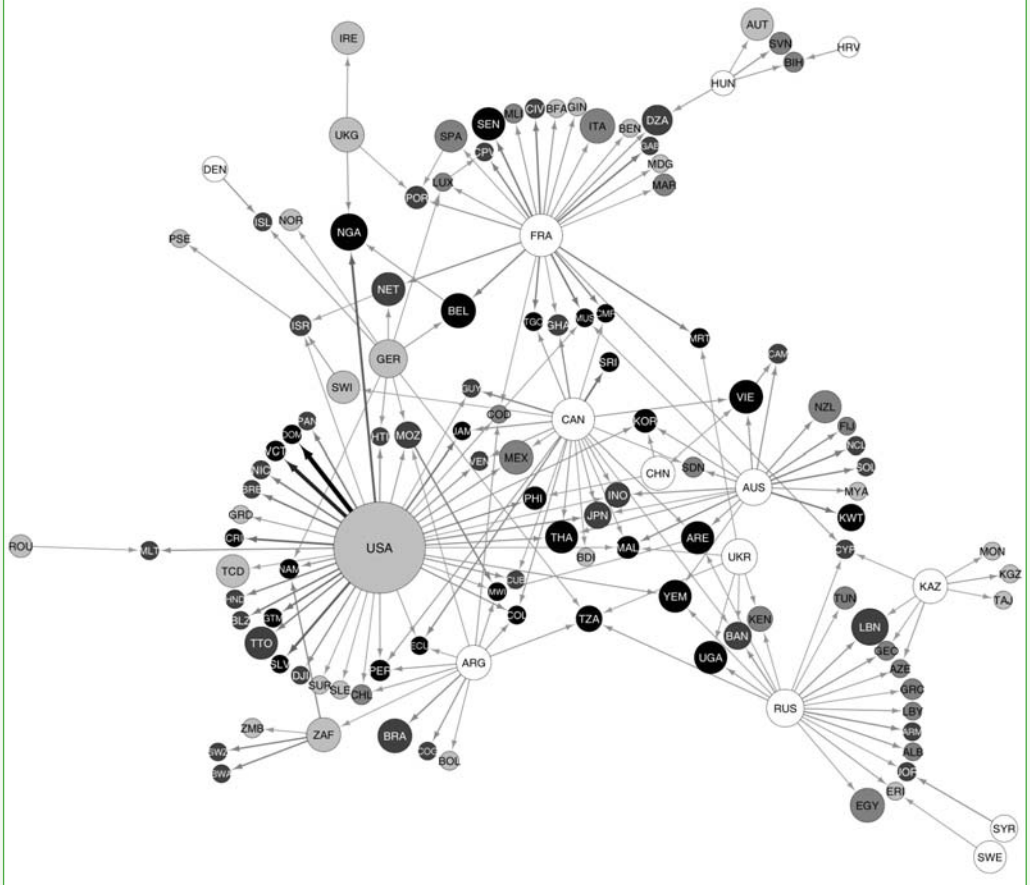
Malaysia, and the Philippines, do not even show up on the map. This is because they are also large rice producers and import only a small fraction of their total domestic consumption. For the PRC, which is also a large rice importer, no incoming arrows are shown on the map because of its reliance on a large number of smaller suppliers.

The trade map for wheat (Figure B5.2) shows that global trade is centered on a few countries—Australia, Canada, France, Kazakhstan, the Russian Federation, and the United States (US). Australia, Canada, and the US are particularly important suppliers for a number of Asian countries, while Kazakhstan and the Russian Federation are key suppliers for Central Asia and other former Soviet republics. The wheat map shows that many Asian countries, such as Indonesia, Japan, the Republic of Korea, Malaysia, the Philippines, and Viet Nam, are highly dependent on imports for domestic consumption. However, the many lines connecting these countries to major suppliers indicate a relatively broad import base involving more suppliers, so risks to wheat supply shocks are relatively mitigated in Asia.

Soybeans form an important part of the diet in East Asia, and a significant portion of domestic consumption is supplied through imports, particularly in Japan and the Republic of Korea. Although not shown here, the trade map illustrates how the PRC holds a central role in the

Figure B5.2: **Wheat Trade Map**



Note: Please refer to Appendix B for a list of three-character economy codes.

Source: See box source.

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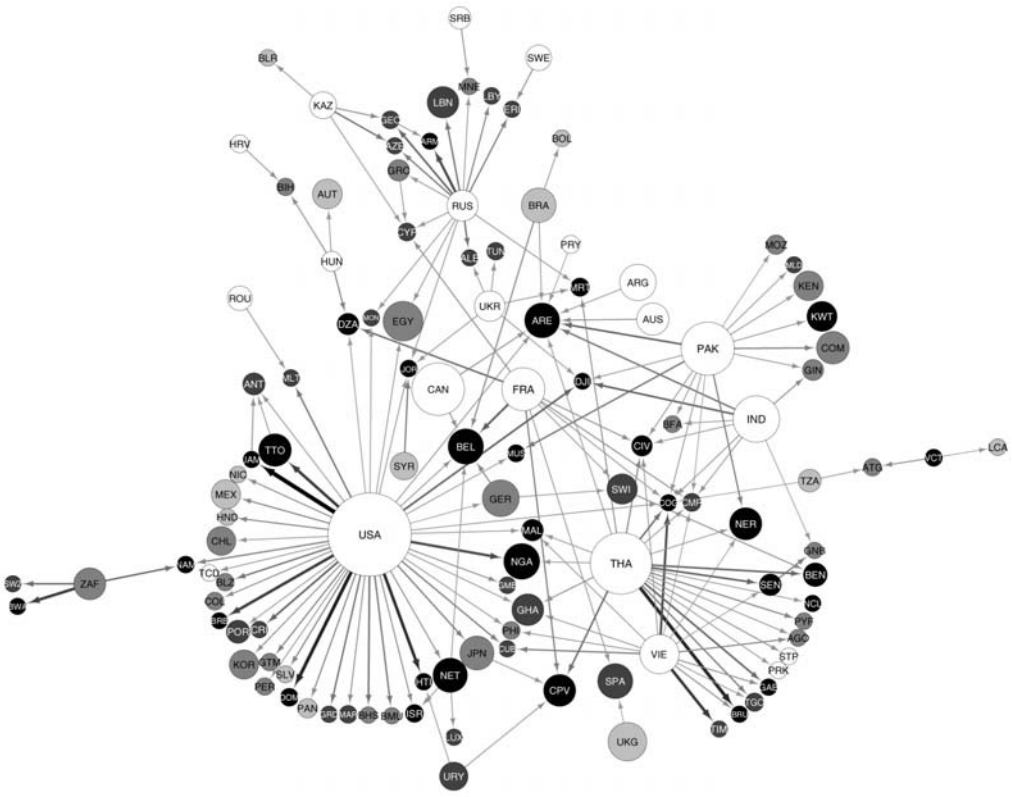
Box 5 *continued*

soybean network as an important supplier as well as importer. Argentina, Brazil, and the US are the main soybean suppliers in global markets.

From a nutritional perspective—abstracting away from food preferences, like that for rice in Southeast Asia—food security relates to the physical and economic availability of food to ensure a sufficient caloric intake (it is, however, recognized that in the long run, a balanced diet delivering sufficient amounts of macro- and micronutrients is essential for true food security). The global trade in nutrition can be calculated using data that aggregate calories from rice, wheat, maize, and soybeans, converting kilograms (kg) to calories based on the Food and Agriculture Organization of the United Nations (FAO) Food Balance Sheets (Figure B5.3). The US is a critical supplier of calories from staples for a large number of countries scattered across the globe, as shown by its centrality in the network map. The large number of countries highly dependent on the US—as represented by the size of its node—indicates its importance in world staple trade with significant influence over the entire network. The map also shows that, in general, countries in Asia dependent on imports for their staples are not very vulnerable to supply disruptions from single country sources—as Asia is home to important global suppliers of calories, such as India, Pakistan, Thailand, and Viet Nam. There are two exceptions, however. One is Brunei Darussalam, which in the caloric network map seems vulnerable due to its high dependence on

Figure B5.3: **Caloric Trade Map**



Note: Please refer to Appendix B for a list of three-character economy codes.

Source: See box source.

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Box 5 *continued*

imports and its high bilateral dependence on Thailand for its caloric consumption. Malaysia also stands out as a black node highly dependent on three big food-exporting countries: Thailand for rice and maize; the US for wheat, maize, and soybeans; and Viet Nam for rice. Imports from these three countries account for over 30% of domestic caloric intake for staples in Malaysia. Despite this, Malaysia's supply risks are mitigated as the other two big suppliers could step in should supply from the third country be disrupted.

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[a] The analysis uses a matrix of world trade in rice, wheat, maize, and soybeans—the four major staples central to food security. The data on quantities traded (in kilogram [kg]) are derived from the United Nations Commodity Trade Statistics Database (UN Comtrade) database for 2006–2008. In relation to any particular food item *f*, say rice, and period *t*, BIPI is the share of rice imports of country *i* from country *j* out of the total supply of rice in country *i* (net of stock adjustments). The stronger country *i*'s reliance on imports from country *j* to meet its domestic demand for rice—which is assumed equal to final domestic supply—the higher the BIPI. Specifically, BIPI is defined as:

$$BIPI_{ij} = \frac{M_{ij}}{\sum_{j=1}^{n}(X_{ij} - M_{ij}) + P_i} = \frac{M_{ij}}{\sum_{j=1}^{n} M_{ij}} \frac{\sum_{j=1}^{n} M_{ij}}{\sum_{j=1}^{n}(X_{ij} - M_{ij}) + P_i} \quad (1)$$

where M_{ij} refers to imports of country *i* from country *j*. X_{ij} refers to exports of country *i* to country *j*, and P_i refers to domestic production in country *i* (all variables are in quantities).

The expression after the second equal sign indicates that bilateral import penetration may be thought of as the product of the share of country *j* in country *i*'s total imports and its overall reliance on imports to satisfy domestic demand. The latter may be termed the total import penetration index (TIPI):

$$TIPI_{ij} = \frac{\sum_{j=1}^{n} M_{ij}}{\sum_{j=1}^{n}(X_{ij} - M_{ij}) + P_i} \quad (2)$$

Source: Brooks, D., B. Ferrarini, and E. Go. Forthcoming. Bilateral Trade and Food Security in Asia. *ADB Economics Working Paper*. Manila: ADB.

Developing Asia has undergone a dramatic structural transformation over the last 2 decades, leading to rising incomes, urbanization, and change in food habits. Diets are becoming more grain- and protein meal-intensive through greater demand for livestock. Clear trends emerge when looking at agricultural trade in the region. As incomes rise, countries report significant increases in imports of meat as well as feed grains to meet the needs of the growing domestic livestock sector. The PRC has already switched from being a net exporter to a major importer of maize and soybeans (Brooks, Ferrarini, and Go, forthcoming). Because the PRC is the world's largest food consumer, a small shift in its net export position could be enough to move global markets, impacting the global food system. The rise of the middle class in developing Asia and the changing dietary composition will require vast areas of farmland to produce grains necessary to raise cattle and other livestock (Jha, Roland-Holst, and Sriboonchitta 2010). This will require expanding agricultural capacity elsewhere, thus leading to greater net food imports for Asian countries.

VI. Climate Change and Food Security

With more than 60% of the population relying on agriculture and food production as a source of income, the Asia and Pacific region is particularly sensitive to the potential damage caused by climate change. Agriculture, fisheries, and livestock will all suffer direct impact, which can lower productivity and food output. Thus, the need to address the effects of climate change on food security is urgent—one requiring an immediate and appropriate response.

The Fourth Assessment Report (AR4) by the Intergovernmental Panel on Climate Change (IPCC) describes how intensifying greenhouse gas (GHG) emissions have affected all continents and most oceans. The evidence shows that many natural systems are being disrupted by regional climate change, particularly increases in temperature (IPCC 2007a).

Although the scientific community has agreed that global warming must be kept at less than 2 degrees Celsius (ºC) above preindustrial levels to avoid dangerous climate change effects, current and pledged commitments are not nearly enough. A World Bank report, *Turn Down the Heat: Why a 4ºC Warmer World Must be Avoided*, warns that a 4ºC warming of the global mean temperature could occur as early as the 2060s (World Bank 2012).

Evidence of climate change is seen in rising carbon dioxide (CO_2) concentrations, rising global mean temperatures, changing precipitation patterns, and rising sea levels.

- **Rising CO_2 Concentrations:** CO_2 emissions have long been on the rise, particularly since the 1950s. From an annual rate of less than 26 billion ton/year in 1990, they are projected to rise to 41 billion ton/year by 2020 (World Bank 2012). Total GHG emissions would reach 56 billion tons of CO_2 equivalent ($GtCO_2e$) in a "business as usual" scenario. If current pledges to reduce emissions are fully implemented, projected emissions in 2020 would range from 53 to 55 $GtCO_2e$—still too high.
- **Rising Global Mean Temperature:** Scientific research shows that humans are the "unequivocal" cause of rising global mean temperatures and climate system warming (World Bank 2012). Thus far, global mean temperatures have increased by roughly 0.8°C compared with preindustrial levels. Recent research shows that increases since the mid-20th century were caused by increased GHG concentrations stemming from anthropogenic activities (IPCC 2007b). One study, for instance, illustrated just how human activity influences short-term temperature variations by removing nonhuman factors such as solar variability, volcanic aerosol effects, and the El Niño–Southern oscillation events (Foster and Rahmstorf 2011).
- **Change in Precipitation Patterns:** Current climate models project that precipitation in tropical precipitation maxima (such as monsoons) and high latitude regions will rise, especially over the tropical Pacific. However, precipitation will decrease in subtropical regions as a consequence of a generally intensifying global hydrological cycle. Global mean water vapor and evaporation are also expected to increase

(IPCC 2007a). In the absence of additional aerosol particle effects (from volcanic eruptions, for example), GHG emissions are expected to heighten the water cycle, making dry areas drier and wet areas wetter (Chen et al. 2011). Based on results from the latest 13 climate models of the World Climate Research Programme's Coupled Model Intercomparison Project Phase 5, total precipitation on wet days is projected to increase by about 10%. Extreme precipitation events are also expected to increase by 20% under the representative concentration pathway 8.5 (4+°C) emission scenario (Sillmann et al. 2013). This adds the substantial additional risk of flooding.

- **Sea-Level Rise:** With more accurate methods of monitoring the rise in sea levels—such as tidal gauges and satellite observations—the IPCC has confirmed that sea levels have risen more than 20 centimeters (cm) from preindustrial times to 2009 (Church and White 2011). The average rate during the 20th century was 1.7 millimeters per year (mm/year) (or 1.7 centimeters per decade [cm/decade]), accelerating 3.2 mm/year (3.2 cm/decade) since the 1990s (Meyssignac and Cazenave 2012). There remain uncertainties as to the share of contributing factors, as the sum of individually measured components is less than the total observed sea-level rise (IPCC 2007a). The rate of observed sea-level increases varies by region, due to causes such as each ocean's distinctive heating, ocean dynamics such as winds and currents, sources and geographical location of changes to the cryosphere (snow cover and solid precipitation, sea ice, lake and river ice, glaciers, ice caps, ice sheets, permafrost and seasonally frozen ground), and subsidence or uplifting of continental margins (World Bank 2012).

The Impact of Climate Change on Food Security

Climate change will affect all three dimensions of food security—availability, accessibility, and utilization. The changing climate affects food production directly, through changes in agroecological conditions, and indirectly, by altering income growth and its distribution, thus shifting the demand for agricultural produce. There will likely be changes in land suitability, potential yields (for example, CO_2 as fertilization), and production of current cultivars. Shifts in land suitability will likely lead to an increase in suitable cropland in higher latitudes and a decline of potential cropland in lower latitudes. Weather is expected to become more variable and volatile, with more frequent and severe extreme events. Fluctuating crop yields and local food supply will make achieving food security more difficult. Semi-arid and subhumid regions will be affected most, reducing crop yields, livestock, and productivity. As these areas are mostly in Sub-Saharan Africa and South Asia, the world's poorest regions with the highest levels of chronic undernourishment will be exposed to the highest degree of instability.

Changes in global food production systems will impact food prices. Potential price increases and negative income effects associated with climate change may have implications for food accessibility. It could also start a vicious cycle where infectious diseases—including water-borne diseases—cause or compound hunger, leaving the affected population even more susceptible to the same or other diseases. This will reduce labor productivity and increase poverty, morbidity, and mortality.

Recent studies offer estimates for the impact of climate change on hunger in different pathways of global development (World Food Programme [WFP] 2009). The risk of hunger can be measured based on the number of people whose incomes allow them to purchase sufficient quantities of cereals (Parry et al. 2004). This naturally depends on the price of cereals and the number of people at given levels of income. Using different modeling approaches, various studies (Fischer, Shah, and Velthuizen 2002; Parry et al. 2004) estimate the potential impacts of climate change for various scenarios under the IPCC Special Report on Emissions Scenarios (SRES). The SRES set up different pathways of socioeconomic development in terms of population and income level, which would affect climate change and the agricultural response at the regional and global levels.[12] The studies suggest that a pathway of continuing high population growth and regional disparities of income (A2 under the SRES scenarios) results in large numbers of people at risk of hunger (Figure 6.1). Assuming no CO_2 effects, the number at risk of hunger would be very high in 2080 under the A2 scenario (as compared to the reference case scenario)—partly because of higher temperatures and reduced yields, but mainly because there are many more poor people under the A2 scenario, which assumes the global population reaches 15 billion (compared with 7 billion in A1). The number of people at risk is much lower in the B1 and B2 scenarios, with lower numbers of poor.

Regional Impact of Climate Change on Food Security

The effects of climate change are highly heterogeneous—with some regions gaining, even if the overall effect is negative. In South Asia, for example, climate change will likely bring a substantial reduction in aggregate crop production by the end of the century. The effect will be larger on wheat than on rice yields; although, on average, rice yields are also projected to decline. Upstream glacial runoff will increase, but mostly during monsoons rather than during the dry season, when water is needed most. Flood risk will also increase.

12 The IPCC (2000) developed four scenarios to explore the uncertainties behind potential trends in global developments and GHG emissions. The scenarios come from different states of the world in two different dimensions: global or regional development, and economic or environmental concerns. The four scenarios, also referred to as storylines, are as follows:

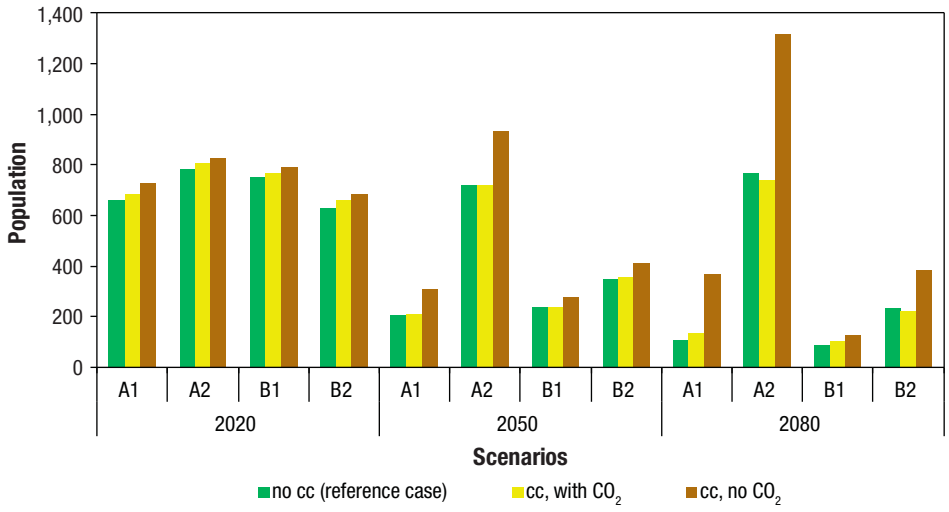
(i) The A1 storyline and scenario family describes a future world of very rapid economic growth, global population that peaks in mid-century and declines thereafter, and the rapid introduction of new and more efficient technologies. Major underlying themes are convergence among regions, capacity building, and increased cultural and social interactions, with a substantial reduction in regional differences in per capita income.

(ii) The A2 storyline and scenario family describes a very heterogeneous world. The underlying theme is self-reliance and preservation of local identities. Fertility patterns across regions converge very slowly, which results in continuously increasing global population. Economic development is primarily regionally oriented, and per capita economic growth and technological changes are more fragmented and slower than in other storylines.

(iii) The B1 storyline and scenario family describes a convergent world with the same global population that peaks in mid-century and declines thereafter, as in the A1 storyline, but with rapid changes in economic structures toward a service and information economy, with reductions in material intensity, and the introduction of clean and resource-efficient technologies. The emphasis is on global solutions to economic, social, and environmental sustainability, including improved equity, but without additional climate initiatives.

(iv) The B2 storyline and scenario family describes a world in which the emphasis is on local solutions to economic, social, and environmental sustainability. It is a world with continuously increasing global population at a rate lower than A2, intermediate levels of economic development, and less rapid and more diverse technological change than in the B1 and A1 storylines. While the scenario is also oriented toward environmental protection and social equity, it focuses on local and regional levels.

Figure 6.1: **Population at Risk of Hunger Under Different Climate Change Scenarios** (millions)



cc = climate change, CO_2 = carbon dioxide.

Note: The figure shows the number of people at risk of hunger (in millions) in three scenarios: no climate change (no cc), climate change with the benefits of carbon dioxide fertilization (cc, with CO_2), and climate change without the benefits of carbon dioxide fertilization (cc, no CO_2). See footnote 12 for an explanation of scenarios A1, A2, B1, and B2.

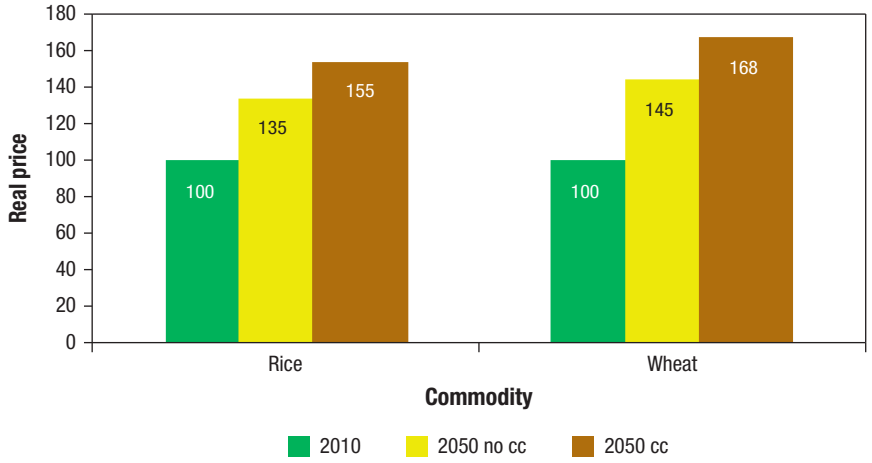
Source: Easterling, W. and P. Aggarwal. 2007. Food, Fibre and Forest Products. In M. L. Parry, O. F. Canzianai, J. P. Palutikof, P. J. van der Linden, and C. E. Hanson, eds. *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, pp. 273–313. Cambridge, UK: CUP. Cited in World Food Programme (WFP). 2009. *Climate Change and Hunger: Responding to the Challenge*. Rome: WFP. http://documents.wfp.org/stellent/groups/public/documents/newsroom/wfp212536.pdf

In general, the climate will likely become more volatile and less predictable. Superimposed on the increasing demand for land for nonagricultural purposes and the effects of land degradation, the effects of climate change are indeed worrying.

Biophysical crop modeling studies provide quantitative estimates of yield effects for the expected climate change by 2050, compared with a no-climate change scenario (Rosegrant 2013). Climate change could reduce yields for irrigated rice by 14%–20%; for irrigated wheat, 32%–44%; for irrigated maize, 2%–4%; and for irrigated soybeans, 9%–18%. The spread in expected yield effects is wider for rainfed crops, with the possibility of some positive effects, especially in more temperate zones. In Pacific island countries, significant yield reductions are expected in traditional staple crops, including sweet potato, taro, and cassava.

Combining these results with economic modeling, food prices of cereals and soybeans are projected to rise from 20% to 70% by 2050 (Rosegrant 2013). Rice and wheat prices will also increase substantially (Figure 6.2). Even without climate change (the middle bar in Figure 6.2), prices of these staples will rise—by 35% for rice and 45% for wheat. The main cause is increased pressure on agricultural resources stemming from nonagricultural demand for land and labor. Climate change adds substantial stress—an additional 20% increase in the real price of rice and 23% for wheat.

Figure 6.2: **Projected Real Price of Rice and Wheat, 2010–2050 (2010 = 100)**



cc = climate change.

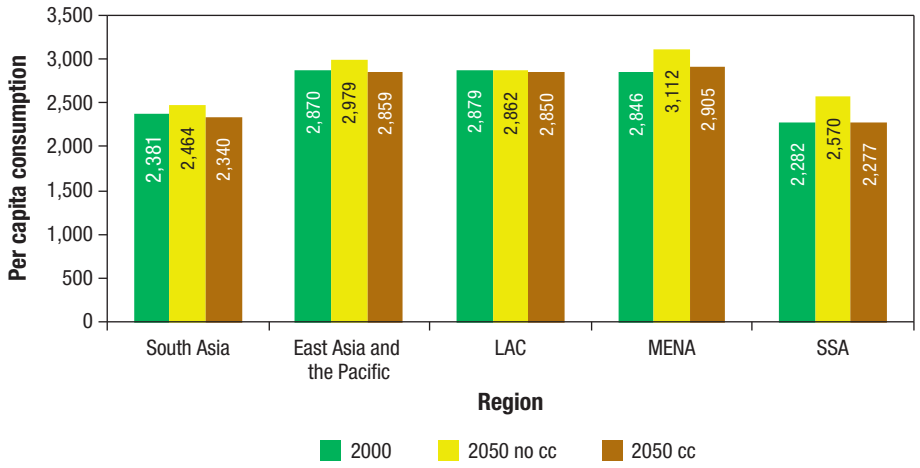
Source: Rosegrant, M. 2013. Climate Change and Agriculture in the Asia-Pacific Region: Impacts and Policy Responses. Paper presented at the Australian Agricultural and Resource Economics Society Annual Conference on Economics, Agriculture, and Natural Resources in the Asian Century. Sydney. 5–8 February.

Compared with the no-climate change scenario, these price increases imply reduced caloric intake (Figure 6.3). In South Asia, caloric intake will drop 10% in the no-climate change scenario. In East Asia and the Pacific, it will drop 7%. Childhood malnutrition—directly linked to caloric intake—will also be affected. Without climate change, the number of malnourished children in South Asia would decline from 75.6 million in 2000 to 52.4 million in 2050. In East Asia and the Pacific, childhood malnutrition is projected to fall from 23.8 million to 12.0 million. But climate change will negate many of these gains. In fact, the projections show climate change will increase the number of malnourished children by 2.0 million in South Asia, and 2.8 million in East Asia and the Pacific relative to the no-climate change scenario (Figure 6.4).

Climate change is a problem particularly for Pacific island countries (Box 6). However, appropriate policies and adaptation measures can help mitigate adverse impacts on food security and protect vulnerable groups. For example, virtually all the climate change-related increase in childhood malnutrition in Pacific island countries could be eliminated through a policy package including (i) an increase in research and extension spending (reaching 2% of agricultural GDP), (ii) optimization of crop varieties to climate change, (iii) increasing the use of nitrogenous fertilizers from 30 to 50 kilograms per hectare (kg/ha), and (iv) applying public incentives to increase fish and livestock production (Rosegrant 2013).

Another big threat is the loss of cropland due to rising sea levels. Using detailed elevation data from the International Food Policy Research Institute (IFPRI) Spatial Allocation Model (ISPAM), the potential impact of rising sea levels on crop production in key Asia and the Pacific countries was estimated (ADB 2009a). An increase of 1 meter and 3 meters in sea levels was used for the calculations for countries with coastal areas included in the ISPAM.

Figure 6.3: **Projected Levels of Caloric Consumption** (kCal/capita/day)

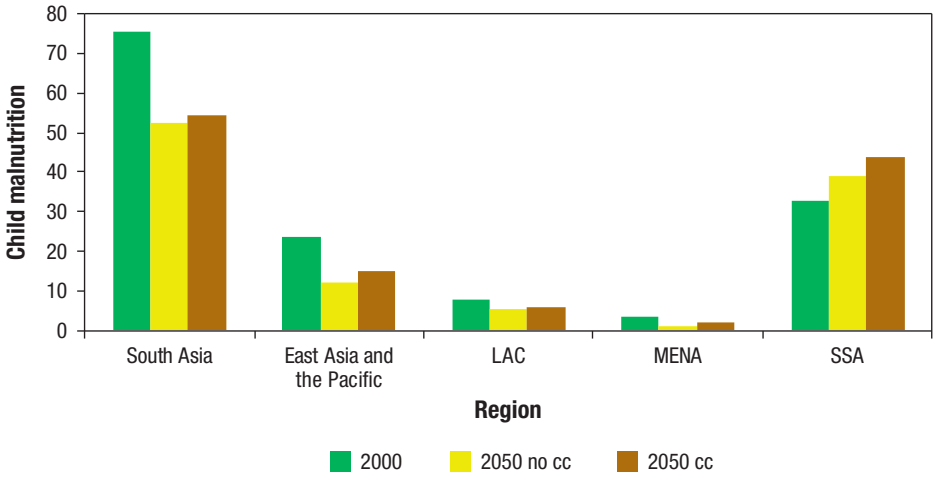


cc = climate change, kCal = kilocalorie, LAC = Latin America and the Caribbean, MENA = Middle East and North Africa, SSA = Sub-Saharan Africa.

Note: Regional groupings are as defined by Rosegrant (2013).

Source: Rosegrant, M. 2013. Climate Change and Agriculture in the Asia-Pacific Region: Impacts and Policy Responses. Paper presented at the Australian Agricultural and Resource Economics Society Annual Conference on Economics, Agriculture, and Natural Resources in the Asian Century. Sydney. 5–8 February.

Figure 6.4: **Projected Levels of Child Malnutrition** (millions)



cc = climate change, LAC = Latin America and the Caribbean, MENA = Middle East and North Africa, SSA = Sub-Saharan Africa.

Note: Regional groupings are as defined by Rosegrant (2013).

Source: Rosegrant, M. 2013. Climate Change and Agriculture in the Asia-Pacific Region: Impacts and Policy Responses. Paper presented at the Australian Agricultural and Resource Economics Society Annual Conference on Economics, Agriculture, and Natural Resources in the Asian Century. Sydney. 5–8 February.

Box 6: Food Security and Climate Change—The Special Case of the Pacific

Projected yield reductions in major staple crops resulting from climate change in the Pacific are substantial (Table B6.1). In particular, the very large effects on cassava yields are serious, considering that cassava is a staple of the poor.

Table B6.1: **Projected Impact of Climate Change on Crop Yields**
(% reduction by 2050)

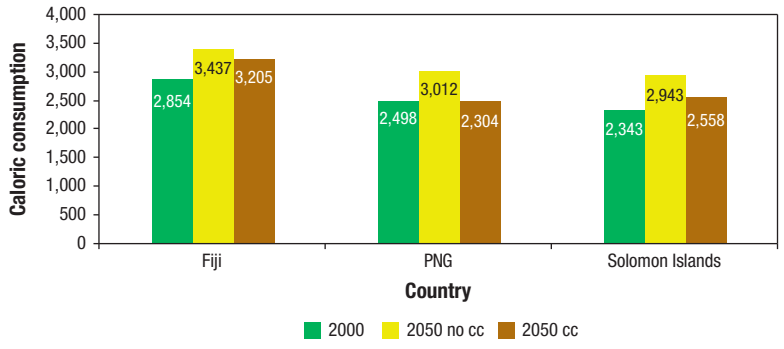
Crop	Fiji	PNG	Solomon Islands
Sugarcane	8	n.a.	n.a.
Rice	4	8	15
Taro	15	13	16
Cassava	37	30	28
Sweet potato	n.a.	11	15

n.a. = not applicable, PNG = Papua New Guinea.

Source: See box source.

These yield effects will, in turn, reduce caloric consumption within the Pacific island countries (Figure B6.1). The impact on Papua New Guinea and the Solomon Islands is especially large. And reductions in caloric intake increase the number of people at risk of hunger (Table B6.2) and the number of children at risk of malnutrition (Table B6.3), both of which are especially worrying for Papua New Guinea.

Figure B6.1: **Projected Levels of Caloric Consumption in Pacific Island Countries**
(kCal/capita/day)



cc = climate change, kCal = kilocalorie, PNG = Papua New Guinea.

Source: See box source.

continued on next page

Box 6 *continued*

Table B6.2: **Population at Risk of Hunger** ('000)

Country	2000	2050 no cc	2050 cc
PNG	1,275	2,156	2,616
Solomon Islands	45	114	165

cc = climate change, PNG = Papua New Guinea.

Note: Data for Fiji are not available.

Source: See box source.

Table B6.3: **Population of Malnourished Children Under Age 5** ('000)

Country	2000	2050 no cc	2050 cc
PNG	172	138	217
Solomon Islands	9	6	10

cc = climate change, PNG = Papua New Guinea.

Note: Data for Fiji are not available.

Source: See box source.

Source: Rosegrant, M. 2013. Climate Change and Agriculture in the Asia-Pacific Region: Impacts and Policy Responses. Paper presented at the Australian Agricultural and Resource Economics Society Annual Conference on Economics, Agriculture, and Natural Resources in the Asian Century. Sydney. 5–8 February.

In the 1-meter scenario, 7.7 million ha of croplands are projected to be submerged, while in the 3-meter scenario, the projection is 16.1 million ha. Rice is expected to be the most affected, losing 4.9 million ha under the 1-meter scenario and 10.5 million ha under the 3-meter scenario, followed by wheat (0.6 million ha and 1.2 million ha) and maize (0.5 million ha and 0.9 million ha). Given the 150 million ha of rice cultivated globally and assuming a 1.5 harvest index for rice, 5% and 11% of rice cropland will be lost under the two scenarios. This could significantly affect global rice production, and hence, prices.

The PRC and Viet Nam face the biggest threat from the two scenarios of sea-level rise. Large areas of wheat and maize would be affected in the PRC (the Pearl River Delta, Yangtze River Delta, coastal areas of Jiangsu Province, and the coastal areas along the West rim of the Bo Hai Sea), while rice lands would be submerged in Viet Nam (the Mekong Delta and parts of the Red River Delta). Bangladesh, India, and Indonesia are also vulnerable to rising sea levels.

The effects of climate change may be largest in tropical and equatorial regions, although varying widely across different temperate and geographic regions (Timmer 2012a). If nothing is done to reduce the impact of climate change, agricultural productivity in Asia and the Pacific will drop, heightening the problem of food security. However, given the geographical heterogeneity of the expected effect—and the scientific uncertainty surrounding them—policy flexibility in adapting to climate change will be extremely important.

Proactive adaptation policies and investments may include developing more drought- and heat-resistant crop varieties, using moisture-conserving tillage methods, and improving irrigation efficiency. Genetic variability could be a relatively easy way for adapting crop varieties to climate change (Iglesias, Erda, and Rosenzweig 1996). Agricultural management also needs to undergo an overhaul—for example, windbreaks to reduce evaporation are a small but effective investment. The most pragmatic adaptive management response will be to change planting dates. Estimates show that small changes—of up to 4 weeks—would be viable for most of Asia (Iglesias, Erda, and Rosenzweig 1996). However, countries such as the PRC and the Philippines may require untenably large shifts in seasonal agricultural activity. The simple truth is that no common or general adaptive measures can be taken without thoroughly assessing local conditions.

Increasing or adjusting irrigation requirements is another effective proactive adaptation measure. Changes in temperature and precipitation, and increased evapotranspiration may require a significant increase in irrigation for most countries and regions. However, having sufficient water resources is prerequisite, with water itself a central management issue for climate change. Investments and countermeasures to reduce soil and water pollution are limited in most developing countries. In the PRC, for example, the estimated maximum area for irrigated farmland has already been reached, meaning intensifying irrigation will likely be restricted in the future. Nonetheless, there remains much potential for improving the efficiency of existing irrigation systems (Erda 1996).

Several adaptations could help cope with these daunting challenges (Aggarwal et al. 2012). Suggested ways to adapt to climate change include (i) better land and water resource management; (ii) improved risk assessment and management, reflecting the increased risk from both floods and periodic drought; (iii) adaptations that provide benefits from reduced GHG emissions; and (iv) improved governance, including regional cooperation. These will require new technologies, reclamation of degraded agricultural land, and community management of soil and water resources. What is clear is that doing nothing is not an option. Investment in the knowledge base required for these location-specific adaptations must start now.

VII. Policy Framework for Food Security

Food security is a complex, multidimensional issue. It is clear that economic growth alone will be unable to resolve the issues of food insecurity in Asia and the Pacific. While rapid economic growth has helped reduce poverty, undernourishment and hunger persist. The global food crisis of 2007–2008—which prevented millions from breaking out of poverty—also underscored how vulnerable national and international food systems are to food and nutrition insecurity.

Global food prices remain significantly higher than pre-crisis levels and will continue to pose a serious global challenge. In response to the crisis, international institutions have taken several initiatives. The UN established a High-Level Task Force on the Global Food Security Crisis in April 2008 to better coordinate international actions to combat hunger and resolve the food crisis. At the FAO World Summit on Food Security in Rome in November 2009, world leaders agreed to urgently work toward eradicating hunger and increasing investment in agriculture. The Committee on World Food Security (CFS)—established in 1974 as a UN forum to review and follow up policies on world food security—is drawing up a Global Strategic Framework for Food Security and Nutrition to guide and recommend coherent actions for countries, regions, and the world. These stress that building food security requires the active participation and commitment of all governments, international agencies, and private stakeholders to forge fundamental and structural change in national and international food systems.

There remains an urgent need to develop an overarching yet multilayered policy framework covering an array of strategic actions to address immediate, short-term concerns as well as to prepare for medium- to long-term issues at all levels. The dramatic increase in global food prices grew out of a confluence of long-term dynamics—including growing populations, rising incomes, and changing dietary patterns—especially driven by developing countries and more contemporary food supply and demand conditions, and aggravated at times by policy responses. Interventions often focus on providing immediate relief to households and improving agriculture-based food supply. However, the complex interactions of various factors in the global food system require a comprehensive and systemic policy framework that goes beyond emergency response.

Specific actions are needed now to address both short- and long-term issues. In the short run, policies should focus on mitigating the immediate impact of high food prices on vulnerable groups—ensuring access to adequate quality food through emergency food assistance and cash transfers, for example. In the long run, scaling up agricultural productivity and investment, promoting rural development, and continuing to tackle the root causes of poverty can promote economic resilience and help build sustainable food security. At the same time, policy makers need to key in on sustainable agricultural production and environmental protection. It is important to recognize the urgency of responding to long-term issues; delayed or inadequate actions today will increase vulnerability to long-term

food insecurity tomorrow. International food markets and governments must be prepared to respond to further supply and demand shocks as well as the effects of climate change, all of which are already behind today's higher food prices and volatility.

Policy actions can be summarized in a food security policy matrix (Table 7). This reflects a two-track approach—similar to the Comprehensive Framework for Action (CFA) adopted by the UN High-Level Task Force on the Global Food Security Crisis—which covers both short- and long-term issues. These policies must be coordinated and applied in a timely manner to successfully address food and nutrition insecurity and progressively improve the resilience of the global food system. Needless to say, these are not mutually exclusive and at times work in synergy—for example, regional cooperation on national agricultural research to develop new seeds or farming techniques. The policy framework also suggests the need for strengthening coordination among national policies and strategies by sharing timely and reliable data and information, and building global and regional monitoring or surveillance systems in response to a crisis.

Interventions to Meet Immediate Needs

Social Safety Nets

Safety nets and social protection programs can offer immediate relief to the poor during temporary bouts of food insecurity. However, the role of social protection for food security extends beyond providing essential assistance to mitigate the impact of short-term natural and economic shocks (Box 7.1). Properly designed and targeted, it can play a crucial role in breaking the vicious cycle of poverty and food insecurity, ensuring food security for all in the long run. A wide array of instruments can be employed to address the vulnerability of people's livelihoods—from social insurance and social assistance, to labor market programs. Social protection programs can also help address market imperfections and failures. Market mechanisms promote competition and efficiency that clearly boost economic productivity—but markets are impersonal and the results of competition can be harsh for those left behind. This may further aggravate social inequality and poverty, which can be passed on to succeeding generations through limited economic opportunities.

A holistic approach should be taken when designing social protection measures to address food insecurity—as part of broader human development and poverty reduction strategies. Access to food is a central focus. As seen during the 2007–2008 food crisis, governments often react to transitory food insecurity by providing blanket subsidies to keep food prices artificially low. However, these types of interventions drain budgets and cannot be viable if food price increases continue and are caused by supply and demand market fundamentals. One option is to build food-based safety nets and related social protection programs for vulnerable communities such as off-farm, landless workers and poor small-scale farm households. Better yet, these programs can be linked to productivity-enhancing measures that can sustainably improve farm incomes and nutrition as well as provide more jobs. Such measures include input trade fairs and farm-to-market road construction, while asset-creating measures include tenure rights and weather-based index insurance, for example.

Table 7: **Food Security Policy Matrix**

Actions	National	Regional/Global
Interventions to Meet Immediate Needs	• Provide emergency food assistance and enhance social safety nets • Offer programmed cash transfers • Target interventions at nutrition	• Provide timely and reliable data and information • Coordinate crisis policy responses • Facilitate flows of emergency assistance • Reduce agricultural trade restrictions and market distortions
Actions to Improve Medium- to Long-Term Resilience	• Promote agriculture and rural development ▪ Improve rural roads and infrastructure ▪ Improve farm access to inputs ▪ Enhance farm productivity through – Agricultural research – Extension services – Postharvest measures • Invest in human development: education and health • Strengthen nutrition education and awareness • Consider building an emergency fund for disaster relief • Introduce insurance and disaster mitigation measures, such as crop insurance and futures contracts • Establish national and regional food reserves and crisis management systems	• Promote research and development, knowledge exchange, and capacity building • Improve monitoring and surveillance of food market conditions • Promote food trade liberalization • Consider mechanisms to promote price stability, such as regional and international food reserves • Enhance collaboration on climate change and accelerate adaptation measures

Source: Authors.

It is critically important to target these programs more effectively and exclusively at the poor—to maximize their impact given limited budgets. One study shows that nontargeted direct cash transfers and food aid have increased dependency and eroded local capacity to generate sustainable incomes (Gilligan et al. 2009).

Cash Transfers

The targeting failures of existing social protection systems raise the question of whether these programs could be replaced by something better. Cash transfer systems might replace in-kind programs altogether (Jha, Kotwal, and Ramaswami, forthcoming), although there may be initial political resistance as beneficiaries from existing corruption and inefficiency can be expected to oppose change. Cash transfers can also encourage households to adopt beneficial behavior—for example, they could be conditional on household participation in education, health, or nutrition services.

Box 7.1: The Role of Social Protection and Safety Nets in Reducing Hunger and Malnutrition

Hunger and malnutrition are key issues that cut across poverty alleviation interventions. Economic access to food remains one of the most serious food security issues, whereas food insecurity is often a source of instability in households, communities, and nations, impeding economic growth and development. As such, food insecurity and poverty are closely interrelated. However, economic growth alone is insufficient to ensure food security. This is why the key to reducing hunger and malnutrition is a "twin track" approach, one that provides both immediate and long-term solutions. In other words, social protection programs form an essential part of any overall development and poverty reduction strategy, encompassing a wide range of policies that fall under social safety nets, insurance, and even labor market support.

From the array of social protection programs, social safety nets may have the most direct effect on the poor. They are geared toward helping the poor cope with risks, especially during times of shocks, such as price increases or calamities, among others. Without requiring any financial contribution from beneficiaries, safety nets take the form of instruments such as transfers and subsidies (Tables B7.1.1, B7.1.2), and are more often than not, targeted at specific segments of the population—the poor, children, or mothers, for example. While social protection should be available to all, resource constraints necessitate targeting to ensure program efficiency and cost-effectiveness. More importantly, targeting runs parallel to the overarching goals of poverty reduction, especially if the targeting mechanisms are clear and executed properly. Transfers to beneficiary households may be based on the minimum food basket cost that provides the required calories and nutrition to household members. This will help guarantee that limited resources are well spent—and cash transfers used to ensure the minimum dietary intake.

Table B7.1.1: Features of Transfers

- Can be preventive (insurance) or palliative (response or assistance)
- Can be cash or in-kind (e.g., food or inputs to agriculture); in some cases both
- Can be unconditional (no commitment from beneficiary) or conditional (dependent upon school attendance, clinic visits, and so on)
- Can be given as payment for employment in public works or construction

Table B7.1.2: Features of Subsidies

- Usually implemented by subsidizing the commodity for a lower market sale value
- Subsidized commodity can either be a universally consumed good or one preferred by specific groups
- Sale of good can be universal (all can avail of the subsidized good) or targeted (only specific groups are able to avail through a mechanism such as vouchers or show of proof)

Sources:

Food and Agriculture Organization of the United Nations (FAO). 2003. *Anti-Hunger Programme. A Twin-Track Approach to Hunger Reduction: Priorities for National and International Action*. Rome: FAO. ftp://ftp.fao.org/docrep/fao/006/j0563e/j0563e00.pdf

———. 2012. *The State of Food Insecurity in the World*. Rome: FAO. http://www.fao.org/docrep/016/i3027e/i3027e.pdf

New technological developments may offer several options for addressing practical problems associated with distribution and targeting. The simplest systems use existing banking and postal systems to distribute cash to targeted groups. A problem arises when these facilities are not readily accessible. In Africa, the wide use of mobile phone systems has provided a solution. Any retail outlet can then be used as a distribution center for cash. Conditionality relating to school attendance and health center participation is possible within cash transfer systems, which have been well developed in Latin America. New systems of biometric identification and smart cards can be used to reduce fraud. Better ways to identify eligible households might be combined with these systems. In India, evidence from the differential coverage of PDS, the main channel for ensuring food safety, and differences in poverty reduction across states shows that states with coverage beyond the officially mandated poverty lines have seen a greater reduction in poverty compared with those that retained the framework of targeted PDS (Himanshu, forthcoming).

Indonesia has already used cash transfers to compensate for economic shocks. In 2008, it reintroduced BLT—the world's largest unconditional cash transfer system—to shield households against the impact of reductions in fuel subsidies. With the assistance of the World Bank, Indonesia was able to develop a transparent system that worked. This well-documented program could be adapted elsewhere.

Overall, it appears that new information technology can implement social safety net programs more efficiently and with less corruption. It may be possible to altogether dispense with the need to redistribute food in kind, replacing it entirely with cash-based systems. Reducing corruption associated with social safety nets is crucial, not only for its direct fiscal implications, but also in changing attitudes.

Interventions Targeted at Nutrition

Poverty and limited access to food are major causes of inadequate food and nutrient intake. Tending to be more vulnerable to food price hikes and other shocks, the poor have to adjust their dietary choices to low-quality food that might translate to lower nutrition. This damage is particularly severe among pregnant women and young children.

Urgent actions are required to improve food and nutrition security among the poor and vulnerable. These include improving incomes, providing targeted social assistance and safety nets, and promoting dietary education. Special attention has to be paid to the health of mothers and children, given the elevated risk of both groups to malnutrition and undernourishment. First, improving smallholder production and productivity can have tremendous impact on food and nutrition security, not only increasing food supply but also raising rural household incomes. Smallholder farmers are responsible for the majority of domestic food production in most developing countries. Efforts to enhance farm production can also be combined with efforts to improve crop and dietary diversity to maximize the impact on nutrition security. As many smallholders are subsistence farmers, the diversification of small-scale production, cultivation of micronutrient-rich crops, and biofortification of staple food crops directly reduce nutrition and micronutrient deficiencies.

Second, social assistance programs should take into account the nutrition and dietary needs of beneficiaries. Food assistance, nutritional interventions, and safety net programs

can be designed in tandem with programs that enhance economic opportunities and reduce poverty, such as school feeding and job creation schemes. Food assistance and related interventions can also better target beneficiaries to improve program efficiency. For example, by channeling food assistance through programs for women or for mothers and their children, the specific food and nutrition needs of these vulnerable groups can be met, and longer-term health consequences can be prevented.

Third, there has been an increasing emphasis on the role of health and education for nutrition security. National food security strategies often focus on agriculture and food supply, neglecting the importance of nutrition. However, evidence is clear that food supply alone may not guarantee that nutrition security will be achieved. In Mexico, for example, malnutrition and stunting persists despite relative food abundance (Neufeld, Chowdhury, and Ruel 2012). Nutrition education and social marketing are essential to improving food and nutrition security, given the strong relationship between nutritional and health knowledge, and nutrition outcomes. Studies show that education and a mother's nutritional knowledge are particularly important for household food allocation and young children's nutritional status (Behrman and Wolfe 1987; Thomas, Strauss, and Henriques 1991). A mother's nutrition and health also directly influence her child's nutrition and health. Moreover, there is often bias and discrimination against girls in household decisions over schooling, health care, and feeding. Pervasive gender bias is an important latent factor for malnutrition and the undernourishment of women and girls. Education is critical in empowering women and reducing gender inequality. Food distribution in households should incorporate nutrition interventions into broader food security and social protection programs.

Actions to Improve Medium- to Long-Term Resilience

Agriculture and Rural Development

Primarily, poverty in Asia remains rural. Thus, a rural-based growth strategy would seem to be an effective way to tackle both poverty and food insecurity. In the 1960s and 1970s, the Green Revolution was the proverbial stone that hit the two birds of poverty reduction and food security—by increasing rural incomes and lowering food prices. It showed rural development and growth can help reduce poverty effectively.

A new growth paradigm should focus on support for agriculture and on increasing rural income opportunities so they are at par with those for urban dwellers. Rural incomes should also be diversified to improve stability, while urban–rural integration must deepen. Investment in rural roads and other infrastructure lowers transport costs, facilitates marketing, and encourages the flow of information. This can go a long way in advancing rural development.

Investing in rural roads and other infrastructure. Public investment in infrastructure, especially roads, is critical for rural development. Good infrastructure lowers the cost and time for trade, and increases reliability, thus boosting flows and benefiting those who use infrastructure services more intensively. The costs of transit delays are especially high for time-sensitive goods like perishable agricultural products. Reduced transport costs simultaneously raise earnings from output sales and lower the cost of inputs. Investment

in new drainage systems, or the rehabilitation of existing ones, must also be prioritized, as good drainage is central to resolving water logging and salinity problems. While profitable irrigation systems can be developed by the private sector, the construction and maintenance of drainage structures are often unprofitable, requiring additional public support.

Improving farm access to key inputs. The vast majority of the poor and vulnerable in rural areas work on small-scale subsistence farms. Therefore, improving smallholder production and productivity should be a priority in promoting food and nutrition security. The production capacity of smallholder farmers is often constrained by limited access to key inputs such as quality seeds, fertilizer, agricultural infrastructure, services (farm credits, for example), and available modern technology. Access to services and credit must be improved. New technologies require high capital inputs or mechanization, while small farmers may find it difficult to adapt. Therefore, enhancing small farm production and productivity requires assistance to strengthen smallholders' access to critical inputs, building and rehabilitating rural and agricultural infrastructure, improving the efficiency of food supply chains, reducing postharvest losses, and expanding agricultural cooperatives.

Improving legal land rights can be an incentive to invest and help improve credit access, which might have been hampered by ill-defined land rights. With continued farm fragmentation, increasing land degradation, and stiff competition for land (agriculture versus nonagriculture, rural versus urban), there is need for more efficient, inclusive, and sustainable land use policies. Tenure rights and migration policies must be reexamined. Aside from these policies, more innovative measures that can organize small-scale farmers and consolidate land holdings are urgently needed to pave the way for a leaner and smaller agriculture base that can produce more with less.

Increasing productivity in vast and fertile upland areas could result in improved livelihoods for the poor in these areas. The practical challenges of transportation and market access are central to increasing crop production in upland areas. But an important issue that must not be overlooked is insecure land rights and encroachment by industrial plantations or politically favored groups. Upland communities are often poor ethnic minorities—food insecure and politically marginalized. While these people can contribute to meeting the food security challenge, they cannot do so without security in the use of ancestral lands. So beyond productivity and logistics, institutional arrangements for these communities must also be examined.

Enhancing agricultural productivity. Improving agricultural productivity is essential for promoting long-term food security and poverty reduction. While better technology is available and can help increase food production, many farmers in Asia still use centuries-old farming techniques. There remains much room for increasing the yields of smaller and less efficient farms, and reducing the amount of food wasted due to poor storage or inefficient processing. Modern farm technology can improve yields, but it often remains beyond the reach of poor farmers without the scale to make adaptation cost-effective, or the knowledge to apply this technology. Agricultural research, extension services, and postharvest measures are three specific areas through which public policy can help improve agricultural productivity.

Agricultural research

The world must produce more food to feed its growing population. But it must do so with fewer natural resources—limited land and water—and less energy, fertilizers, and pesticides while coping with rapid societal change. As with the Green Revolution of the 1970s, investing in agricultural R&D offers the most feasible long-term solution to this conundrum. Scientific research has been behind many innovations in agriculture, providing solutions to the problems of food security. It can again provide solutions in the future if people understand that investments need to be made now. The challenge for the research community is to develop resilient agricultural systems using rational, affordable strategies that not only increase production, but also achieve food security for households and individuals. Research also needs to be interdisciplinary and to address the diverse needs of smaller farms.

In Asia and the Pacific, it is important to increase food production by diversifying crops and finding alternatives to rice and wheat. A case in point is the potato, which has emerged as one of the more important food crops in the region. Potato crops have high yields and produce more edible energy and protein per unit area and time than many other crops. It also fits well into multiple-cropping systems prevalent in the region. However, most potato varieties selected for production in the region were developed for European or North American climates. Research can contribute to developing potato varieties more suited to tropical climates as well as to production technologies and postharvest processing.

Research is also needed in the area of climate change. Agriculture is extremely vulnerable to climate change and water availability; climate change impacts agriculture in many ways, particularly in countries vulnerable to natural disasters. Higher temperatures reduce crop yields while encouraging weed and pest proliferation. In addition, droughts, floods, and typhoons could occur more frequently and with greater ferocity. Over the long term, climate change can cause desertification and saltwater intrusion, further damaging already scarce arable land. There is a need for research to build climate change resilience across agricultural systems as well as to ensure crop diversity. Research needs to focus on developing crops that can withstand extreme weather. For example, the International Rice Research Institute (IRRI) continues to develop rice varieties that can withstand flooding and above-average salt levels.

Given the Asia and Pacific region's agroecological diversity, research could help bring more arable land into production. A recent study illustrates that investing in climate change adaptation in agriculture not only increases the chances of sustaining productivity (thus helping to stabilize food prices), but also reduces the pressure of bringing new lands into agriculture (Lobell, Baldos, and Hertel 2013). The study indicates that benefits can be best achieved in higher-yielding and more land-scarce areas such as South and East Asia.

To be sustainable, agricultural research must be demand driven, consider farmers' concerns, and have results-based strategic action plans. Rural technological research cannot be done in a vacuum; rather, research on building cost-effective business

models and financing options for farmers using new technologies is essential. The research should be evidence-based and generate new data, so the information can feed into policy and project programming. Research that is oriented toward sustainability and profitability will also attract private sector interest, which could drive substantial agricultural R&D as it innovates to compete.

Extension services

Research by itself does not increase farm productivity. New knowledge must be transmitted to farmers. Extension services are one bridge between the scientists who develop solutions and the farmers who need them. Research and best practices can translate to increased yields and improved food security only when they are communicated to and adopted by farmers. Wesley and Faminow (2012) argue that extension systems in much of Asia and the Pacific are outdated—top-down extension models with little attention to local conditions. Their study (2012) notes "farmer-oriented approaches to rural innovation that emphasize the importance of mutual learning between formal and informal knowledge systems."

An earlier study supports and extends this bleak assessment, describing public extension services that are hierarchical and favor large farmers (Qamar 2006). These services are often linked to commercial input suppliers, detracting from objectivity and sometimes resulting in excessive chemical inputs. On the other hand, the study also notes that the links between extension services and research institutions are "notoriously weak." As a result, extension staff are often poorly informed about farmers' needs and are poorly motivated. Among the study's recommendations are outsourcing extension services, where socially and economically feasible, to the private sector, combined with appropriate regulatory controls. The study emphasizes the potential for using new information technology as a tool to facilitate—but not replace—conventional extension services. Reforms are needed to bring about an extension system that is demand driven, responsive to farmers' needs, and accountable to the farmer, rather than the supply-driven systems prevailing across much of the region.

Communication technology bridges the information gap for remote areas, giving them access to extension services. Innovative strategies for combining Internet, telecommunications, video, and print technologies at appropriate levels are bridging this gap and allowing farmers to make better production and marketing decisions (McLaren et al. 2009).

Postharvest measures

Efforts to increase agricultural productivity need to be complemented by efforts to reduce postharvest loss. For poor and food-insecure smallholders, a reduction in losses has an immediate and significant impact on household livelihoods. Postharvest food losses span the entire supply chain from harvest to final household consumption. In developing countries, more than 30% of food loss occurs after harvesting and during processing—and this is usually reused alternatively (as animal feed, for example).

In industrialized countries, losses occur mostly at the consumer end, as waste. Postharvest losses in developing countries are mainly due to financial, managerial, and technical limitations in harvesting techniques, storage and cooling facilities, infrastructure, packaging, and marketing systems. Research and technology can help provide practical solutions to postharvest losses—ranging from careful harvesting and packaging to more advanced storage systems to prolong freshness and shelf life. Moreover, as dietary habits change in Asia and the Pacific, postharvest measures will become increasingly important in maintaining the quality of fresh produce and meat products. These food categories will require specialized infrastructure such as cold supply chains and storage, humidity control, and laboratory and testing facilities to ensure regulatory standards are met.

Extension services, which have traditionally focused on production, can play an additional role to include the integration of marketing and value chains into existing extension systems and to link farmers and other agencies (Sulaiman, Hall, and Raina 2006). For example, a private company in Thailand developed a new supply chain model for fresh produce, in which deliveries are made daily and directly from small farmers organized under the company's contract farming model. Assigning collection points and exercising postharvest control minimize losses and improve product quality (Uathaveekul 2011). This is an example of the changing nature of agricultural extension, in which the private sector takes the initiative where there is potential for win-win solutions. Public extension services will need to be selective, focusing on clients and sectors where there is a need for public sector involvement, but stepping aside where the private sector can do a better job.

Human Capital Investment: Education and Health

Human capital investments in health and education—and investments in basic infrastructure like water and sanitation—are key to poverty reduction and food security. While economic growth is a necessary condition for poverty reduction and consequently food security, the link between economic growth and food security may be weakened if the poor have limited access to human capital formation and basic infrastructure. Prioritizing investment in basic schooling, health, and nutrition not only directly enhances individual welfare but also builds higher average incomes in the long run. Human capital development directly improves food security by ensuring a healthy agricultural workforce and providing farmers with the skills to adopt modern and more productive farming technologies.

Nutrition Education and Awareness

Food security policies need to ensure that people have not only sufficient food, but also the right kind of food. In many developing countries, trends in dietary patterns complicate the nutrition situation. Rapid income growth and urbanization are causing a shift in dietary patterns away from traditional starches and cereals, and increasingly toward processed foods, animal products, sugars, fats, and edible oils. For many developing countries, this nutritional transition has been accompanied by an increasing overweight incidence and risk of obesity in urban areas, while high rates of food insecurity and undernutrition continue in rural areas. Dietary diversification—including increased consumption of total energy and

animal protein—is a boost for the poor, who have monotonous diets. However, nutrition education and awareness have to be strengthened during this transition, especially for low-income urban households, as highly processed food that is low in micronutrient content poses increased health risks. Overall, it is important to promote dietary diversification through nutrition education and awareness programs, while public health and education must be fully integrated into national food security strategies and policies.

Crisis Prevention and Risk Management

Managing and mitigating the risks threatening food security require a three-pronged approach. The first and arguably the most crucial step is risk assessment—understanding and prioritizing risks, gauging their potential impact, and identifying who will be affected. The second is to provide safety nets and other disaster relief measures to mitigate the immediate impact for vulnerable people and communities. Third, a risk management system should have longer-term prevention and adaptation measures to help people and communities adapt to the changing new environment and build resilience to risks.

Practically all food security strategies and policies laid out in this report are about better risk management, but it is worth highlighting the importance of food security risk analysis and monitoring systems (Box 7.2). Identifying who are food insecure and vulnerable to food insecurity, where they are, and why they are insecure or vulnerable should be the

Box 7.2: Features of a Comprehensive Food Security Risk Assessment and Information System

The important elements of a food security risk analysis are

(i) Risk identification and the development of risk, hazard, and vulnerability maps;

(ii) Food security risk monitoring systems based on key indicators identified in the risk, hazard, and vulnerability maps;

(iii) Needs assessments during emergencies;

(iv) Food security information management platforms; and

(v) Capacity building of national and regional institutions.

An effective food security risk management information system should cover

(i) Indicators that represent the risks to food availability, access, and utilization;

(ii) Identified geographical areas and communities;

(iii) Information on the main causes of food insecurity and risks to livelihoods, and the probable impacts on households;

(iv) Information on risk management efforts that governments, communities, and households can implement;

(v) Tools for the early detection of risks; and

(vi) A comprehensive contingency plan.

Source: Haile, M. and L. Bydekerke. 2012. Improving Food Security Risk Management for Sustainable Development. In C. Ghenai, ed. *Sustainable Development – Education, Business and Management – Architecture and Building Construction – Agriculture and Food Security*. Shanghai, PRC: InTech.

first step even before discussing what measures are needed to mitigate their vulnerability. The source of food security hazards—local, national, or international—and whether they are transitory or chronic in nature must be identified as well. Moreover, risk analysis and monitoring need to gauge the likelihood of these threats, the historical distribution of hazards, and the probable impacts on vulnerable populations. Finally, all this information, once gathered and analyzed, must be fed into a monitoring and early warning system that can help policy makers, firms, and households adapt to foreseeable hazards and take mitigation measures.

Emergency Funds for Disaster Relief

Building an emergency fund for communities and nations could also be considered part of the risk management system to provide a buffer during food crises. The fund could be used to finance safety nets for those suffering transitory food insecurity. The private sector can be offered incentives—such as tax deductions—to contribute to the fund, which can be run by a government agency in partnership with the private sector. The fund can be linked to insurance against natural disasters and other calamities, and used in conjunction with risk management to help mitigate the effects of crises and disasters.

Crop Insurance and Futures Contracts

Weather is a key source of uncertainty over a farmer's projected income, and thus impacts investment and production decisions. Weather-based crop insurance can help mitigate this insecurity, giving farmers a chance to try more productive, even riskier, activities such as alternative crop selection or the adoption of new technologies. On the other hand, futures contracts—which assure farmers of specified prices for output—can also help mitigate risks caused by price volatility. Futures help guarantee that farmers receive a minimum income from their harvest, which can contribute toward poverty reduction. The impact of insurance and disaster mitigation measures can extend beyond simple fiduciary benefits, as such measures reduce uncertainty for farmers' incomes and food security. One important aspect of food security concerns certainty over future meals. By smoothing shocks to household income, crop insurance and futures contracts allow households to invest in other important items, such as education. Reduced uncertainty over food security therefore allows more spending on human resource development, which can improve the chances of escaping poverty.

Coordinated Responses to Enhance Resilience

The 2007–2008 food crisis highlighted a number of weaknesses in international food markets. While fundamental and structural forces—including growing populations, rising incomes, and increasingly constrained resources due to climate change—have been behind recent surges in global food prices, reduced national grain stocks, export and import restrictions, and speculation in futures and commodity markets have aggravated market imbalances at times, amplifying price volatility. At the height of the food crisis, some governments adopted trade and subsidy policies to stabilize domestic food prices and complement food safety nets. While some of these measures aimed to help relieve immediate pressures on

the poor, policies such as export restrictions, direct price controls, and general subsidies can further distort markets and eventually become ineffective and fiscally unsustainable. Therefore, it is important for countries to make more comprehensive assessments of the impact of new policies and to take action accordingly.

There is a clear need for countries to respond to global food crises in a coordinated manner to prevent policies or actions that may have undesirable consequences for other countries and international food markets. The international community needs to strengthen cross-border cooperation for emergency support and better management of international food markets.

First, emergency food reserves and funding facilities can allow the rapid delivery of humanitarian aid to the most vulnerable countries or populations in the wake of a food crisis. Governments can improve emergency access to food by linking village and national stocks to regional and global stocks, and by facilitating the release of grain stocks to other countries in crisis situations. National and international food stocks, if strategically managed, can also help reduce food price volatility.

Second, agricultural trade offers opportunities to effectively manage international food markets and price volatilities. The international community needs to show a strong commitment to removing undue trade restrictions and reviving stalled global trade talks—including agricultural negotiations under the World Trade Organization (WTO) Doha Round. Subsidy programs, especially in developed countries, should be removed to provide a level playing field to already disadvantaged farmers in developing countries. It is also important to build consensus on national policies for biofuel and environmental management toward sustainable agriculture.

Third, coordinated actions require the comprehensive assessment and monitoring of international food markets, and better coordination and information sharing. To be better prepared and provide timely support for the most vulnerable, governments and the international community need to establish mechanisms to collect and share reliable and timely data and other information. One interesting recommendation for regional and global coordinated action is the “Resources 30” approach recommended by *Resources Futures: A Chatham House Report* (Lee et al. 2012). The proposal involves an informal network of key food producers and consumers that could develop and agree on rules and norms for the regional and global food system. An example is ASEAN’s pilot testing of a multi-stakeholder dialogue through its Rice Trade Forum. Finally, cooperation across Asia and the Pacific is essential if climate adaptation and GHG mitigation strategies are to be effective, in both nations and the region.

Emergency Food Reserves

Low food stocks make markets vulnerable to excessive price volatility, even against minimal supply or demand shocks. Private stock levels are determined by those who hold stocks for profit (Williams and Wright 1991). At times, stock levels from market-driven processes are too low from a social perspective; as they increase the likelihood of price spikes, there is market failure in relation to the level of privately held stocks. Not only do poor people suffer

from food insecurity induced by price spikes, but government action can also magnify the problem.

The existence of market failures suggests that it may make sense for countries to maintain emergency stocks. Storage can be costly, of course. But if these are released in a transparent, preannounced manner and only when prices are unusually high, national grain stocks can stabilize prices and help domestic food security. Nevertheless, releasing food stocks has only a limited and temporary effect on domestic price stability, if free trade allows the international price to be transmitted domestically. For example, when prices surge, an importing country might release rice stocks domestically to force the local price below international levels. But unless exports are prohibited, private agents would buy rice at the low domestic price and sell it internationally for profit.

Nonetheless, emergency reserves can be important in meeting the immediate food needs of a population hit by transitory food insecurity. Each ASEAN member, for example, maintains national rice reserves. But these reserves need to be expanded, particularly for large rice-importing and -exporting countries in Asia. ASEAN includes three of the largest rice-importing countries in the world—Indonesia, Malaysia, and the Philippines—and two of the largest rice exporters—Thailand and Viet Nam. Regionally coordinated reserves could be useful in mitigating the effects of short-term supply shocks by allowing countries to tap into the regional reserve pool and to reduce the storage cost nationally. One study finds that maintaining domestic stocks has been more effective than international trade in coping with short-term negative supply shocks (Jha, Kubo, and Ramaswami, forthcoming).

A proposal for an internationally coordinated grains reserve (von Braun and Torero 2008) requires a physical reserve of about 5% of current levels of food aid—or about 300,000 tons of food in wheat units—to be managed by the WFP. Under this proposal, the Group of Eight (G8) Plus 5 countries[13] are to be tapped for contributions to the reserves and for financing. International food reserves, however, run a high risk of coordination failure and incur high costs. For example, a proposal by Lin (2008) on international coordinated grains reserves could cost about $1.05 billion per year.

On the other hand, there have been noticeable initiatives at the regional level to improve food reserve management and price stability. After the 2007–2008 rice crisis, the ASEAN Integrated Food Security (AIFS) Framework and its implementing mechanism, the Strategic Plan of Action and Food Security in the ASEAN Region (SPA-FS), were established. They aim to prevent or mitigate problems caused by extreme rice price volatility through regional and national food reserves, the expansion of food trade, the strengthening of market information, and the increase of food productivity. Other initiatives within the region are the ASEAN Plus Three Emergency Rice Reserve (APTERR), the ASEAN Food Security Information System (AFSIS) project, and the pilot ASEAN Rice Trade Forum.

Designed to complement members' existing national rice reserves, APTERR helps mitigate supply shock effects using forward contracts and streamlined release procedures, helping

13 The G8 consists of Canada, France, Germany, Italy, Japan, the Russian Federation, the United Kingdom (UK), and the US, while the Plus 5 countries refer to the emerging economies of Brazil, the PRC, India, Mexico, and South Africa.

Box 7.3: The ASEAN Plus Three Emergency Rice Reserve

The Association of Southeast Asian Nations (ASEAN) Plus Three Emergency Rice Reserve (APTERR) was established in July 2011, in a ministerial agreement between the ASEAN+3 members—ASEAN (Brunei Darussalam, Cambodia, Indonesia, the Lao People's Democratic Republic [Lao PDR], Malaysia, Myanmar, the Philippines, Singapore, Thailand, and Viet Nam), plus the People's Republic of China (PRC), Japan, and the Republic of Korea.

APTERR is a buffer against immediate threats to food security caused by disasters and market volatility associated with calamities. Earmarked rice reserves total 787,000 tons. Voluntary donations in cash or rice comprise stockpiled reserves. APTERR stocks can be released to a member that is unable to cope with an emergency through its national reserves alone, and is unable to procure needed rice supplies through normal trade. Day-to-day management is handled by a secretariat hosted by Thailand under the supervision of the APTERR Council.

Sources:

Association of Southeast Asian Nations (ASEAN) Plus Three Emergency Rice Reserve (APTERR). 2012. *20 Frequently Asked Questions About APTERR*. Primer published with the support of the Asian Development Bank, with financing from the Japan Fund for Poverty Reduction.

Clarete, R., L. Adriano, and A. Esteban. Forthcoming. Rice Trade and Price Volatility: Implications on ASEAN and Global Food Security. *ADB Economics Working Paper*. Manila: ADB.

countries respond more quickly (Box 7.3). This multilateral effort to coordinate publicly held rice reserves—and the investment in developing rules, procedures, and the capability to anticipate rice shortages—is noteworthy. A suggestion is for APTERR to consider including Bangladesh, India, and Pakistan to expand the regional rice reserve system (Timmer 2010).

Trade Liberalization

Trade liberalization covering food can help stabilize food prices and ensure food security. But national policies often vie against liberalization when it comes to food. Rice trade in ASEAN is a prime example. It is constrained by the level of imports, not exports (Clarete, Adriano, and Esteban, forthcoming). ASEAN's capacity to export rice expanded when Viet Nam became one of the world's top five rice exporters. After 2000, ASEAN's rice imports hardly changed while its exports increased, particularly to external markets. This shows that exporting countries have the capacity to expand if there is added demand for rice in the world market. Like Viet Nam, Cambodia and Myanmar hold the potential to boost regional rice supplies, given adequate demand and investment in the supply chain. In Cambodia, investments to modernize road infrastructure, logistics, and rice mills could increase the country's marketable surplus.

However, rice-importing ASEAN members seem reluctant to liberalize their own rice markets, as seen by the preferential rice tariff rates in the ASEAN Free Trade Area (AFTA). Although some countries agreed to reduce their respective preferential import tariffs—the Philippines to 30%, Indonesia to 25%, and Malaysia to 20%—these remain significantly higher than the usual free trade area tariff rates. The region's large exporting countries—Thailand and Viet Nam—have likewise contributed to reducing the rice trade. In 2008, Viet Nam restricted rice exports to avoid importing excessive price fluctuations. And Thailand's paddy-pledging program—which artificially raises the domestic price of rice—is virtually a rice-export limiting policy. While Thailand may be able to pass on some subsidy costs to

the global market, it is limited in doing so as other large rice exporters—India, Pakistan, and Viet Nam, for example—do not need to make world rice consumers pay more than rice production costs.

An important reason importing countries embrace protectionist food self-sufficiency is the fear of losing access to food when others restrict exports. Thus, to promote international trade in food, rules banning export restrictions should be strengthened. Negotiating multilateral rules on export restrictions, or even a reduction in import restrictions on food, will likely be very difficult. Here, regional cooperation holds potential. Food-importing countries may be able to negotiate for the commitment of food-exporting countries to ban unilateral export restrictions by agreeing to reduced levels of self-sufficiency in exchange. This could be further augmented by agreements for the establishment of emergency food stocks and financial aid. These measures could help deepen regional trade in food and better enable the region to respond to food crises.

During past food crises, export and import restrictions were important contributors to food price volatility, together with low food stocks and speculative trading in futures and commodity markets. In the absence of mechanisms to prevent market failure, introducing export bans might be rational at times from an individual country's perspective. This is exactly what happened during the 2007–2008 crisis, when the Russian Federation banned wheat exports, and India and Viet Nam did the same for rice. These bans stemmed from the desire to protect domestic consumers from high international prices. But the bans themselves exacerbated international price instability and, according to one estimate, they were responsible for almost half the international rice price increase (Headey 2011).

The response of some importing countries also contributed to the price increase. Fearful of being unable to obtain rice for domestic consumption, the Philippines—at the time, the world's largest importer of rice—sharply increased its demand for imported rice, to replenish stock levels held by the government's NFA. This further exacerbated the rise in international price.

While government responses are not necessarily irrational from a national point of view, their global effect magnifies the volatility of the international food prices. There may be better responses to the global crisis from an international perspective. One option is an internationally agreed prohibition against export bans. Export bans are legal under existing WTO agreements. The proposal to prohibit export bans for food through the WTO was discussed by the Group of Twenty (G20)—and it is possible some progress can be made. While desirable, WTO action may not be fully effective. If spikes in international prices are transmitted to domestic markets, governments could risk social unrest. Past social unrest suggests it would be difficult for the governments of developing countries to enforce these rules amid international price spikes. Further, the proposal does nothing to prevent panic import buying. So efforts to boost stock levels—particularly internationally coordinated grains reserves—should continue to complement trade measures to improve how international food markets function and maintain food price stability.

At the regional level, there remains the need to review current levels of national reserves and consider more efficient regional options. Since the 2007–2008 crisis, major rice importers,

through self-sufficiency programs, have increased the regional and global stocks-to-use ratio to very comfortable levels. This will likely lead to even thinner rice trade globally, and hence, higher price volatility. It may be useful to review the level of national reserves and complement these with more efficient and higher regional reserves (for example, the APTERR) as well as investments in regional rice value chain logistics.

Market Information Systems and Networks

Accurate and timely information on food markets and stocks would be an essential element for efficiently coordinating national policies and actions to maintain food price stability. Efficient reserve utilization requires timely and accurate information on food markets and stocks. Generating and correctly interpreting market information can also prevent speculation from descending into a full-blown food crisis. Although trade imbalances played an important role in explaining the 2007–2008 rice crisis, market uncertainty and speculation appear to have aggravated the situation and amplified price fluctuations. Moreover, given the centrality of food, price volatility not only increases speculation but also induces hoarding—as households, firms, and governments stock up on essential supplies, expecting difficulties ahead. Although evidence remains patchy, hoarding may have contributed to turning temporary market imbalances into a full-blown food crisis involving panic buying on a massive scale.

While it is important to invest in gathering information about the food market system, interpretation and utilization are just as critical. A regular regional forum of policy makers willing to share and interpret food market and stock information, and coordinate policies in response to developing events would help immensely. Having a vibrant regional futures trade in food would help as well. Aside from reducing market risk, futures trade provides a convenient platform for disseminating market information. Active trading and pricing information gives better signals about market conditions and helps form the best estimates for future prices. Speculation is a necessary evil. Like its counterpart in financial securities or other commodities, rice futures trading would need to be well regulated to maintain its integrity.

A coordinated information system would enhance market transparency and rebuild confidence in the international agricultural trading system. Regional information sharing mechanisms are also needed. The ASEAN Food Security Reserve Board is a good example. It can convene the ASEAN Rice Trade Forum to provide a platform for ASEAN members to share and analyze rice market information, and coordinate policy actions for mitigating the adverse effects of rice price volatility. Through the forum, members can discuss measures to make regional rice trade more open, develop incentives for increased private sector participation in the regional rice value chain, and find ways to improve rice productivity.

Another initiative is the AFSIS project, which has been gathering and disseminating market information and developing an early warning mechanism. While it is necessary to provide AFSIS with reliable, up-to-date, and demand-driven information, it is also important to develop its capacity to accurately interpret market information and provide policy analysis.

There are novel ways of using information and communication technology (ICT) for market information sharing and dissemination, providing extension services and rural finance, and

developing geographic information system (GIS)-based early warning systems. ICT can be used to enhance the efficiency of food distribution networks, by allowing the seamless transit of food along the food supply chain through various intermodal, rural–urban warehouse and transport points. Policies and institutional arrangements for private–public partnerships that harness ICT for market information systems and food distribution networks could facilitate access and more inclusive food distribution. These should be combined with consumer awareness communication strategies that address access to nutritious and safe food.

Collaboration on Climate Change

Building better climate resilience requires strengthening adaptive capacity nationally and regionally, and ensuring appropriate adaptation policies and investments are made and institutions strengthened. Adaptation measures should be an extension of development policy, designed to eradicate the structural causes of poverty and food insecurity (ADB 2009a). The links between poverty and food security should enable a streamlined approach to achieve both. These include the "top-down" options such as developing efficient agricultural markets, reducing distortions and subsidies in agricultural policies, continuing trade liberalization policies, enhancing social protection and microfinance, disaster preparedness, and in general, mainstreaming climate change in designing agricultural policy (ADB 2009a). Nevertheless, neither development policies nor autonomous adaptation measures alone will be enough to enable developing countries in Asia and the Pacific to adequately prepare for climate change.

Effective climate adaptation needs to take existing development policies beyond their current capacity through improvements and better coordination. Innovative policies include changing investment priorities and resource allocation for agriculture and across relevant sectors. Both "hardware" and "software" investments—such as human capacity building, education, and health—are needed. Climate change risk sharing and risk management are most critical to improve the overall adaptive capacity of developing countries. This is particularly true, for example, in pricing carbon to increase the value of practical sustainable farming practices. Integrated water management systems that use water resources efficiently are a key proactive adaptive measure. The continual support of technological development and technology transfer is a global public good—as the huge initial investment requirements go far beyond the capacity of any individual developing country. Establishing or upgrading early warning systems and sharing information on the effects of and responses to climate change must be a worldwide collaborative effort.

Developing appropriate climate policy priorities should target the most vulnerable countries first—usually, but not exclusively, those least developed. Specific climate action plans within each developing country should be integrated into national development plans to enmesh with poverty reduction strategies, through consultations with bilateral and multilateral donors, international and national civil society organizations, the scientific community, and policy advisory groups. Without country-specific integration, processes for policy coordination, a comprehensive climate adaptation plan, or strategies for dealing with agriculture and food security cannot happen.

Lessons learned for one are lessons learned for all. Nationally, regionally, and globally, existing knowledge and experience must be shared. Concrete climate adaptation measures and practices used in developed countries should be shared with developing countries so they can be adapted to local conditions, if suitable. Funding the relevant research agenda on climate change impacts on food security, and assisting developing countries in coming up with flexible arrangements for intellectual property rights may probably be the best way of generating a new, sustainable, greener revolution of technology and practices. Building new contract arrangements for trial testing, adoption, and dissemination may require support from multilateral development organizations.

VIII. Summary and Conclusion

For the countries of Asia and the Pacific, food security is a major concern. Good progress in reducing the prevalence of undernutrition has been made over the last 2 decades, especially in Southeast Asia and East Asia; in South Asia, that progress has been only moderate. Despite this, undernourishment remains far too high. In South Asia alone, the malnourished population exceeds that of Africa. Child malnutrition is a continuing social problem, especially in South Asia and the Pacific island countries.

Over the coming decades, the difficulties in improving food security will become more severe. As populations grow and diets shift from staple cereals toward livestock products, the structure of final demand will change—with livestock feed and biofuel demand becoming more important. Nonetheless, the demand for staple foodstuffs will continue to increase. Nonagricultural demand for land and water will outbid agriculture, and the increase in agricultural output must be met with reduced resource inputs.

Sustained increases in agricultural productivity are required if supplies are to be enough to prevent significant increases in food prices. But this must occur in an environment of great uncertainty. Climate change will require the adaptation of traditional agricultural systems—including, in some cases, the physical location of agricultural production. The need for infrastructure investment and R&D will increase dramatically.

Enhancing food security pivots on two main drivers: (i) reducing poverty incidence, primarily but not entirely driven by economic growth; and (ii) keeping the real price of food stable and affordable. Agricultural productivity growth contributes to both. Spikes in food prices—like those in 2007–2008 and 2010–2011—delay poverty reduction and compound food insecurity. Where markets fail, food and social safety nets need to provide protection against livelihood risks and allow an adequate level of food consumption for vulnerable groups.

National efforts are central to food security. Achieving food security requires measured and balanced policies that promote agricultural productivity and price stability, increase the availability of and access to food, and ensure adequate nutrition, especially for children. The majority of Asia's poor live in rural areas, which makes promoting vibrant agricultural and rural sectors a priority. The focus should be on more localized, smallholder, and sustainable agriculture. The issues of smallholder farmers rest largely in access to inputs, technology, and markets. Addressing these would necessitate reinforcing strategic efforts to enhance agricultural research, invest in infrastructure, and promote trade. The proper mix of short-, medium-, and long-term policies must be crafted based on natural endowment, infrastructure, stage of development, the agro-processing industry, trade liberalization, and fiscal strength.

National food security strategies have often focused on agriculture and food supply, neglecting the importance of nutrition. However, evidence is clear that food supply alone may not achieve nutrition security. Undernourishment and micronutrient deficiency have a major impact on children's cognitive development and remain a serious concern in many developing countries. Investment in health and education, and in water and sanitation infrastructure are critical. In particular, special attention has to be paid to nutrition education and social marketing for better food and nutrition security, given the strong relationship between nutritional and health knowledge, and nutrition outcomes.

Food security requires collaboration beyond national borders and internationally coordinated responses. There are three broad areas where global and regional cooperation can help ensure food security and reduce excessive price volatility: (i) establishing emergency food reserves and aid, (ii) sharing market information, and (iii) promoting trade. Food price instability often coincides with low stock levels. The level of food stocks can be suboptimal if left solely to private business decisions. Current levels appear too low to avert any temporary supply or demand shocks, and may require appropriate tax or price incentives to induce higher levels. Accurate and timely information on food markets and stocks is also critical to preventing market speculation from spiraling into a food crisis. Through regular dialogue, policy makers in the region can assess market trends and help coordinate policies in response.

Finally, agricultural protectionism remains part of the problem, not the solution. It accentuates international price volatility. When importers and exporters attempt to insulate domestic markets, the effects can be offsetting. Domestic prices within each group of countries are left unchanged, but higher international prices are forced onto others. International cooperation can prevent these counterproductive, beggar-thy-neighbor attitudes. Food security requires open international markets for food, research and innovation, increased productivity, and regional—if not international—cooperation.

Appendix A

Regional Groupings

ASIA AND THE PACIFIC

CENTRAL AND WEST ASIA	
Armenia	the Kyrgyz Republic
Azerbaijan	Tajikistan
Georgia	Turkmenistan
Kazakhstan	Uzbekistan

EAST ASIA	
Hong Kong, China	Mongolia
Japan	the People's Republic of China
the Republic of Korea	the Democratic People's Republic of Korea

PACIFIC	
Australia	Papua New Guinea
Fiji	the Marshall Islands
the Federated States of Micronesia	Samoa
Kiribati	Solomon Islands
Nauru	Timor-Leste
New Zealand	Tonga
Palau	Vanuatu

SOUTH ASIA	
Afghanistan	the Maldives
Bangladesh	Nepal
Bhutan	Pakistan
India	Sri Lanka

SOUTHEAST ASIA	
Brunei Darussalam	Myanmar
Indonesia	the Philippines
Cambodia	Singapore
the Lao People's Democratic Republic	Thailand
Malaysia	Viet Nam

OTHER REGIONS

AFRICA

Angola
Burundi
Benin
Burkina Faso
Botswana
the Central African Republic
Côte d'Ivoire
Cameroon
the Democratic Republic of the Congo
Congo
Comoros
Cape Verde
Djibouti
Algeria
Egypt
Eritrea
Ethiopia
Gabon
Ghana
Guinea
Gambia
Guinea-Bissau
Equatorial Guinea
Kenya
Liberia
Libya
Lesotho
Morocco
Madagascar
Mali
Mozambique
Mauritania
Mauritius
Malawi
Mayotte
Namibia
Niger
Nigeria
Rwanda
Sudan
Senegal
Saint Helena
Sierra Leone
Somalia
São Tomé and Principe
Swaziland
Seychelles
Chad
Togo
Tunisia
Tanzania
Uganda
South Africa
Zambia
Zimbabwe

EUROPE

Albania
Andorra
Austria
Belgium
Bulgaria
Bosnia and Herzegovina
Belarus
Cyprus
the Czech Republic
Denmark
Estonia
Finland
France
Germany
Greece
Croatia
Hungary
Ireland
Iceland
Italy
Lithuania
Luxembourg
Latvia
Moldova

EUROPE *continued*	
Macedonia	Spain
Malta	Serbia
Montenegro	Slovakia
the Netherlands	Slovenia
Norway	Sweden
Poland	Switzerland
Portugal	Turkey
Romania	the United Kingdom
the Russian Federation	Ukraine

LATIN AMERICA AND THE CARIBBEAN	
Aruba	Guatemala
Anguilla	Guyana
the Netherlands Antilles	Honduras
Argentina	Haiti
Antigua and Barbuda	Jamaica
the Bahamas	Saint Kitts and Nevis
Belize	Saint Lucia
Bolivia	Mexico
Brazil	Nicaragua
Barbados	Panama
Chile	Peru
Colombia	Paraguay
Costa Rica	El Salvador
Cuba	Suriname
Dominica	Trinidad and Tobago
the Dominican Republic	Uruguay
Ecuador	Saint Vincent and the Grenadines
Grenada	Venezuela

MIDDLE EAST	
United Arab Emirates	Lebanon
Bahrain	Oman
Iran	Occupied Palestinian Territories
Iraq	Qatar
Israel	Saudi Arabia
Jordan	Syria
Kuwait	Yemen

NORTH AMERICA	
Bermuda	Greenland
Canada	the United States

Source: Authors.

Appendix B

Economy Codes

Code	Economy	Code	Economy
ABW	Aruba	CAM	Cambodia
AFG	Afghanistan	CAN	Canada
AGO	Angola	CCK	the Cocos Islands
AIA	Anguilla	CHL	Chile
ALB	Albania	CIV	Côte d'Ivoire
AND	Andorra	CMR	Cameroon
ANT	the Netherlands Antilles	COD	the Democratic Republic
ARE	United Arab Emirates		of the Congo
ARG	Argentina	COG	Congo
ARM	Armenia	COL	Colombia
ASM	American Samoa	COM	Comoros
ATA	Antarctica	COO	the Cook Islands
ATG	Antigua and Barbuda	CPV	Cape Verde
AUS	Australia	CRI	Costa Rica
AUT	Austria	CUB	Cuba
AZE	Azerbaijan	CXR	Christmas Island
BAN	Bangladesh	CYM	the Cayman Islands
BDI	Burundi	CYP	Cyprus
BEL	Belgium	CZE	the Czech Republic
BEN	Benin	DEN	Denmark
BFA	Burkina Faso	DJI	Djibouti
BGR	Bulgaria	DMA	Dominica
BHR	Bahrain	DOM	the Dominican Republic
BHS	the Bahamas	DZA	Algeria
BHU	Bhutan	ECU	Ecuador
BIH	Bosnia and Herzegovina	EGY	Egypt
BLR	Belarus	ERI	Eritrea
BLZ	Belize	EST	Estonia
BMU	Bermuda	ETH	Ethiopia
BOL	Bolivia	FIJ	Fiji
BRA	Brazil	FIN	Finland
BRB	Barbados	FRA	France
BRU	Brunei Darussalam	FSM	the Federated States
BWA	Botswana		of Micronesia
CAF	the Central African Republic	GAB	Gabon

Code	Economy	Code	Economy
GEO	Georgia	LIE	Liechtenstein
GER	Germany	LSO	Lesotho
GHA	Ghana	LTU	Lithuania
GIB	Gibraltar	LUX	Luxembourg
GIN	Guinea	LVA	Latvia
GMB	Gambia	MAC	Macau Special Administrative
GNB	Guinea-Bissau		Region of the People's Republic
GNQ	Equatorial Guinea		of China
GRC	Greece	MAL	Malaysia
GRD	Grenada	MAR	Morocco
GRL	Greenland	MCO	Monaco
GTM	Guatemala	MDA	Moldova
GUM	Guam	MDG	Madagascar
GUY	Guyana	MEX	Mexico
HKG	Hong Kong, China	MKD	Macedonia
HND	Honduras	MLD	the Maldives
HRV	Croatia	MLI	Mali
HTI	Haiti	MLT	Malta
HUN	Hungary	MNE	Montenegro
IND	India	MNP	the Northern Mariana Islands
INO	Indonesia	MON	Mongolia
IRE	Ireland	MOZ	Mozambique
IRN	Iran	MRT	Mauritania
IRQ	Iraq	MSR	Montserrat
ISL	Iceland	MUS	Mauritius
ISR	Israel	MWI	Malawi
ITA	Italy	MYA	Myanmar
JAM	Jamaica	MYT	Mayotte
JOR	Jordan	NAM	Namibia
JPN	Japan	NAU	Nauru
KAZ	Kazakhstan	NCL	New Caledonia
KEN	Kenya	NEP	Nepal
KGZ	the Kyrgyz Republic	NER	Niger
KIR	Kiribati	NET	the Netherlands
KNA	Saint Kitts and Nevis	NFK	Norfolk Island
KOR	the Republic of Korea	NGA	Nigeria
KWT	Kuwait	NIC	Nicaragua
LAO	the Lao People's Democratic	NIU	Niue
	Republic	NOR	Norway
LBN	Lebanon	NZL	New Zealand
LBR	Liberia	OMN	Oman
LBY	Libya	PAK	Pakistan
LCA	Saint Lucia	PAL	Palau

Appendix B

Code	Economy	Code	Economy
PAN	Panama	SVK	Slovakia
PER	Peru	SVN	Slovenia
PHI	the Philippines	SWE	Sweden
PNG	Papua New Guinea	SWI	Switzerland
POL	Poland	SWZ	Swaziland
POR	Portugal	SYC	Seychelles
PRC	the People's Republic of China	SYR	Syria
PRK	the Democratic People's Republic of Korea	TAJ	Tajikistan
		TCD	Chad
PRY	Paraguay	TGO	Togo
PSE	Occupied Palestinian Territories	THA	Thailand
PYF	French Polynesia	TIM	Timor-Leste
QAT	Qatar	TKM	Turkmenistan
RMI	the Marshall Islands	TON	Tonga
ROU	Romania	TTO	Trinidad and Tobago
RUS	the Russian Federation	TUN	Tunisia
RWA	Rwanda	TUR	Turkey
SAM	Samoa	TZA	Tanzania
SAU	Saudi Arabia	UGA	Uganda
SDN	Sudan	UKG	the United Kingdom
SEN	Senegal	UKR	Ukraine
SHN	Saint Helena	URY	Uruguay
SIN	Singapore	USA	the United States
SLE	Sierra Leone	UZB	Uzbekistan
SLV	El Salvador	VAN	Vanuatu
SOL	Solomon Islands	VCT	Saint Vincent and the Grenadines
SOM	Somalia	VEN	Venezuela
SPA	Spain	VIE	Viet Nam
SRB	Serbia	YEM	Yemen
SRI	Sri Lanka	ZAF	South Africa
STP	São Tomé and Principe	ZMB	Zambia
SUR	Suriname	ZWE	Zimbabwe

Source: Authors.

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17–18 September 2012

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Food Security in Asia and the Pacific

This synthesis report is the result of close, collaborative research initiated by the Asian Development Bank in partnership with Foreign Affairs, Trade and Development Canada; the Asia-Pacific Economic Cooperation; and the Liu Institute for Global Issues at the University of British Columbia. Fourteen background papers were commissioned to investigate food security issues particularly pertinent for Asia and the Pacific. The report synthesizes and collates the primary findings from these papers to articulate key policy challenges and opportunities related to food security in the region.

About the Asian Development Bank

ADB's vision is an Asia and Pacific region free of poverty. Its mission is to help its developing member countries reduce poverty and improve the quality of life of their people. Despite the region's many successes, it remains home to two-thirds of the world's poor: 1.7 billion people who live on less than $2 a day, with 828 million struggling on less than $1.25 a day. ADB is committed to reducing poverty through inclusive economic growth, environmentally sustainable growth, and regional integration.

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