

Feeding Five Billion Asians

A Socioeconomic Perspective

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Abstract

This paper reviews the prospects for long-term food security in Asia, where a significant number of malnourished individuals still live after decades of mixed progress. Evidence shows that poverty reduction on its own will not do the job of eradicating hunger, nor will only increased food production. The region's contribution to high and volatile international food

prices is well known, but Asia's potential contributions toward future decreased price uncertainty are much less cited. The changing composition of future food demand in the region will depend on the extent to which poverty reduction effectively leads to middle class expansion, which remains unclear.

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Feeding Five Billion Asians: A Socioeconomic Perspective

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1. Introduction

The World Bank recently declared victory on halving extreme poverty before 2015 (World Bank 2012a). In contrast, progress on reaching the target of halving the proportion of people suffering from hunger has been modest since 1990, and this relative progress was insufficient to reduce the absolute number of hungry people in the world in the last two decades. The Asian region has experienced a more mixed cross-country performance. The percentage of malnourished children in South Asia has improved only modestly from dismal initial levels despite economic growth and solid progress in poverty reduction. In East Asia, progress has been considerable, and, in some cases, outstanding. Still, almost two-thirds of the world's undernourished people live in Asia (FAO 2011).

Two obvious questions arise: Why has progress in reducing malnutrition not been achieved across the entire Asian region? And looking forward, will the region as a whole be able to feed its growing population, estimated to reach 5 billion by 2050, and do so nutritiously? In a recent review of food security in Asia, Fan, Menon, and Brzeska (forthcoming) make it clear that because of the multi-dimensionality and complexity of hunger and malnutrition, only a comprehensive set of policies that simultaneously improve the targeting and scaling up of nutrition-specific interventions, empower women, promote technological innovation, address sanitation and health care, and promote the capacity of local governments will substantively dent malnutrition in the region. It is the different extents to which all these policies are aligned that explain the different levels of hunger and nutritional achievements. Looking ahead, analyses of

future food demand agree that Asia will continue to be a major contributor to world food price spikes. They also agree that its inevitably richer population will not only demand more food, but also a more diversified diet (Nelson et al. 2010; ADB 2011; USGC 2011; Alexandratos and Bruinsma 2012; FAO 2009).

This paper contests both claims, arguing that the region has also played, and will most likely continue to play, a critical role in averting deeper and longer global price spikes. Furthermore, it is unclear that a richer Asian region will necessarily swell the ranks of its middle class enough to cause substantial changes in dietary diversity. Section 2 reviews the nutrition trends in the region and compares them with poverty achievements in the same period. In section 3, the region's contributions to the recurrent global food price hikes and volatility since 2007 are compared with its potential to help slow down and reverse such trends in the future. Section 4 discusses the role that future sociodemographic changes could have on the demand for more food and a more diversified diet in Asia.

2. Reducing Extreme Poverty Is Not Enough to Eliminate Hunger

On February 29, 2012, the World Bank (2012a) announced that in 2010, the developing world had managed to meet the first target of the first of the Millennium Development Goal—namely, to reduce extreme poverty by half (as measured by the population living under US\$1.25 a day). This milestone was achieved despite the international financial crisis. The reduction of poverty in East Asia, led by China and followed by reductions in Indonesia, accounts for a large part of this achievement. The figures are spectacular, both in absolute and relative terms. At the beginning of the 1980s, the region had the highest indexes for poverty (surpassing even those seen in Africa),

with 77 percent of its population living on less than US\$1.25 a day per person. By 2008, this figure had dropped to only 14 percent.¹

These achievements in poverty stand in stark contrast to the global trend in hunger. According to recent figures from the Food and Agriculture Organization (FAO 2012d), the percentage of hungry people in the world—unable to consume 1,800 kcal per person per day—has declined only slightly, from 16 percent in 1990 to 13 percent in 2008. This modest improvement was not enough to offset the absolute number of people facing starvation, which rose from 848 million in 1990 to 850 million in 2008. This number has been rising due to successive crises in the cost of food, the international financial crisis, and the recent famine in the Horn of Africa. Estimates of the nutritional effects of crises since 2007 (Tiwari and Zaman 2011; Brinkman et al. 2010) indicate that between 63 and 91 million more people have been added to the total number of people facing starvation.² In its latest report on fulfillment of the Millennium Development Goals, the United Nations warns that if the historic trends in hunger reduction and the high prices of food (not to mention their volatility) continue, it will be very difficult to meet the goal of reducing hunger in many regions of the world (UN 2012). But the regions in which this target *will* be met by 2015 are East Asia and Latin America. The enormous progress in China since 1990, as well as in Indonesia and the Philippines, supports these predictions. In China alone, the starving population declined from 210 million in 1990 to 129 million in 2008 (FAO 2012c). At the same time, major progress has been made in average caloric intake in China, which increased from 2,580 kcal a day per person in 1990 to 2,990 in 2008 (FAO 2012c). In East Asia, the rates of malnutrition in children under five years of age have been cut in half, from 15 percent in 1990 to 6 percent in 2009.

These absolute and relative trends, however, are not consistent throughout Asia. In contrast to the promising results in East Asia, the percentage of malnourished children in South Asia has declined only slightly, from 52 to 43 percent between 1990 and 2009, despite the area's economic growth and reduction in poverty. Even more disturbing (and inexplicable) are the figures on child malnutrition according to socioeconomic level. Although it is well known that shortages of nutritious food, poor diet and hygiene, lack of access to sanitary facilities, and the resulting high incidence of diarrheal diseases contribute to very high rates of malnutrition in poor children (about 60 percent in 2009), it is much more difficult to explain why as many as 40 and 26 percent of South Asian children in the fourth and fifth wealthiest household quintiles of the distribution, respectively, are also malnourished (UN 2012). Yet another finding emphasizes the heterogeneous nature of the situation in Asia. In the 17 countries of East Asia and South Asia in which the United Nations monitors progress toward the goal of eliminating hunger, only two (Myanmar and Vietnam) have achieved the goal of reducing their 1990 malnutrition levels by half (UN 2012). Of the others, five (Cambodia, China, the Philippines, Sri Lanka, and Thailand) are on track to reach the target, but five more have made insufficient progress (Bangladesh, Indonesia, Lao People's Democratic Republic, Mongolia, and Nepal), and three have not made any progress or have lost ground (India, the Democratic People's Republic of Korea, and Pakistan).³

All of these absolute and relative numbers point to two conclusions. First, progress in the reduction of extreme poverty (and, though it is not emphasized here, economic growth) is not in perfect alignment with progress in nutrition, at least when measuring poverty in terms of income and consumption. Second, Asia is not at all homogenous in terms of reducing poverty and meeting nutritional targets: East Asia—particularly China—has made a disproportionate positive

contribution to global progress in terms of both poverty and hunger, while South Asia has done so much more modestly.

3. The Asian Contribution to Turbulent World Food Prices Today... and to Their Possible Solution

Much has been said about the challenge of feeding today's global population of 7 billion, and tomorrow's 9 billion, while dealing with severe threats to environmental sustainability and, more recently, the rising and volatile cost of food at both the global and national levels (FAO 2009; Godfray 2010; Nelson et al. 2010; USGC 2011; Alexandratos and Bruinsma 2012; EJDR forthcoming). The key question is whether the pace of future agro-technological progress will be sufficient to meet the increasing demand of food from the growing population. Using FAO data, Beddow, Pardey, and Alston (2009) have shown that average annual crop yield growth rates for corn, wheat, rice, and soy declined between 1961 and 1989, and again between 1990 and 2007. However, these global rates conceal marked regional differences. Increases in productivity in China went from 2.29 to 4.45 percent per worker and from 2.81 to 4.50 percent per hectare from 1961 to 1989 and from 1990 to 2005 (compared with world levels of 1.12 percent and 2 percent), respectively. However, this spectacular growth in productivity is not a phenomenon that extends to the rest of Asia. When China is excluded, the growth of productivity in Asia actually slowed during the period in question, as it did in the rest of the world, with the exception of Latin America. Interestingly, Alexandratos and Bruinsma's (2012) projections maintaining current agricultural yield growth suggest that the world would be producing more grain than required by the estimated demand through 2050. Yields would expectedly increase by 44 kg per hectare per

year up to 2050 in line with the historical trends observed since 1960.⁴ The more optimistic scenarios of Nelson et al. (2010) in terms of overall productivity growth and yields' growth specific to maize, wheat, and cassava (exceeding 2 percent increases per year) in developing countries further confirm a favorable ending to the challenge.

The increase in returns, along with (more modest) improvements in land use and manpower⁵ have made it possible to address the global aggregate demand to feed a population that has been growing at an accelerated pace over the last four decades (Southgate 2009). With regard to land use, it is interesting to note that worldwide expansion of area devoted to grain production was actually rather modest, from 648 million hectares in 1961 to 676 million in 2001, whereas the area used for the cultivation of fruit, vegetables, and oils nearly doubled during the same period. Tilman et al. (2011) estimate that if yields in developing countries' croplands increased to levels close to those of high-yielding nations, the future global demand for land expansion would be still be relatively modest (less than 200 million hectares by 2050) compared to the scenario with current productivity gaps between developed and developing countries (with a required additional billion hectares of land to be cleared).⁶

Available data on current and future caloric intake support this claim. At the start of the new century, agricultural production was guaranteeing 17 percent more calories per person than 30 years earlier, despite a 70 percent increase in population.⁷ FAO calculations indicate that this increase is sufficient to ensure a daily intake of 2,720 kcal per person (FAO 2012a). In a similar line, Tilman et al. (2011) forecast that global demand for food calories would increase by 100 percent through 2050. Nelson et al. (2010) report a range of caloric availability for the developing world in excess of 3,000 and below 2,400 kcal per person depending on assumptions

on yield productivity, population and income growth, and climate change. These improvements may bring about reductions of between 10 and 45 percentage points in malnourishment rates for children younger than age five for the period of 2005–50.

Unsurprisingly, FAO (2002) concludes that the world is producing enough food to feed everyone, and even to respond to the diversity of demand. Fundamentally, the problem is that many people do not have land to cultivate, enough income to purchase food, or access to adequate safety nets. That conclusion does not mean to downplay the actual challenge of feeding the world's (and, specifically, Asia's) increasing population, but brings access to food and not simply the production of food to the center of the debate. Moreover, maintaining current yield growth rates still need to be sustained for decades at an annual cost that FAO estimates to be in the vicinity of US\$83 billion in additional investment in agriculture across developing countries. That amount represents a financing gap of 50 percent of the current private and public investments in agriculture in the developing world, which average US\$142 billion per year (FAO 2009).

In addition to lack of income to buy food and additional resources for agriculture productivity, a sustained but volatile increase in the nominal prices of food began at the start of the new century and gained strong momentum starting in 2007. The World Bank's global Food Price Index (2005 = 100) went from 77 in January 2000 to 220 in June 2008, and, after a series of fluctuations, ended up at 223 in February 2011 (World Bank 2012b). In the case of East Asia, the United Nations Children's Fund (UNICEF 2011) estimates that domestic prices increased by almost 90 percent between January 2007 and April 2008; domestic prices then fluctuated until November 2010, when they matched the peak in 2008 and remained at these levels through the first half of

2011. With this trend, East Asia has become the region with the fastest rise in food prices, surpassing South Asia, the rest of the developing regions, and average prices worldwide (FAO 2010; UNICEF 2011).

Much has been written about the causes and consequences of the recent food crises.⁸ Cuesta (2010) has summed up the causes in what he calls a “perfect storm,” where a series of factors and circumstances have converged to trigger a sudden surge in prices.⁹ In the perfect storm hypothesis, the structural causes cited most often have to do with increased demand—as well as changes in its composition—in emerging countries, led by China and India. In an example of poor policy making, during 2007 and 2008, the governments of China, India, and Vietnam imposed bans or restrictions on the export of rice to neighboring importers within the region, such as Indonesia, Bangladesh, and the Philippines. Another recent example of this type of policy is the credit program for growers in Thailand, known as the Rice Mortgage Scheme. In this program, the Thai government guarantees domestic farmers prices well above market levels, which has resulted in substantial loss of competitiveness in Thai rice exports among other exporters in the region (to the point of threatening Thailand’s status of the world’s leading exporter of rice).¹⁰

An important aspect of the volatility that surrounds international food prices is their high sensitivity to a variety of factors, including uncertainty about available food stocks. Again, the role that Asia plays in this uncertainty is a major determining factor, even more so in the current context of low stock levels, which in the case of corn have never been lower. The new G-20 Agriculture Market Information System (AMIS), which is designed to improve information about agricultural markets, shows substantial differences in the estimates of grain stocks in Asian

countries, depending on whether the data are reported by the FAO or the United States Department of Agriculture.¹¹ Thus, for example, the differences in grain stock estimates vary by 13 percent in China, 32 percent in Indonesia, and 53 percent in Vietnam (similar to differences of over 40 percent in Brazil or Kazakhstan), according to AMIS (2012). With respect to safety nets—a critical instrument to mitigate the effects of high and volatile food prices and natural disasters—a recent World Bank report (World Bank 2011b) indicates that between 2008 and 2011, 80 out of the 137 countries analyzed had weak or nonexistent social welfare systems, and only 9 of these countries made a decisive effort to improve their systems. Of the nine countries, only one of them is in East Asia—Cambodia. Others, such as Thailand, Vietnam, and Malaysia, have not made major improvements. China already had strong capacity in this area and has continued to improve its social protection systems.

These arguments show the significance of the Asian contribution to the recent food crisis. Less cited, however, is the contribution that the region can make—and, in fact, is already making—toward being better prepared for future food crises. Despite the shortcomings mentioned above, several of the countries in Asia decided voluntarily to participate in AMIS. Recently, countries such as Pakistan and India have stepped up to fill the worldwide gap created by Thailand's increased prices for rice exports. Also, the Asian region—along with Africa—leads the way in developing innovative agricultural production practices, which have come to be referred to as “smart climate agriculture.” The goal of this type of agriculture is to simultaneously offer increased agricultural productivity (thus reducing poverty and food insecurity); improved crop resistance to extreme weather conditions (adaptation); greater sequestration of carbon emissions; and curtailment of deforestation (mitigation). An illustrative—rather than exhaustive—number of examples of smart climate agriculture include programs for the restoration of mangrove

forests in Vietnam's Mekong Delta, which acts as a line of defense against typhoons and floods, and reforestation of the Loess Plateau in China. Another widely cited example is the development of financing mechanisms in the province of Qinghai in the north of China to compensate farmers during transition to lower carbon emissions. Also in China, the use of biogas for cooking in the province of Guangxi is estimated to be saving women up to 60 days per year, time they formerly spent collecting wood and tending to cooking fires (World Bank 2011a). The Asian region, especially China, is also witnessing other innovative agro-technological practices, such as vertical farming. Vertical farming, an expansion of the traditional indoor farming, consists of harvesting in multi-store buildings in quantities and varieties enough to sustain large cities without significantly relying on resources beyond the city limits (Despommier 2010). Whether vertical farming will result in considerable increases in agricultural productivity will depend to a large extent in the ability of its technology to use of abundant and cheap natural light rather than artificial light as it is currently the case (The Economist 2010).

Even these few examples underline that the scale of intervention varies considerably from case to case. Whether or not the region will be able to scale up these interventions and sustain them over time will determine to a large extent Asia's exact contribution to solving the challenge of feeding its population in the future. Current evidence does reveal potential for scaling up these interventions, but also shows that scaling up smart agriculture projects is by no means automatic or spontaneous.

4. Closing the Circle: The Equalization (or Not) of Asia Will Largely Determine Its Food Future

Looking to the future, according to United Nations projections, by 2040, the world will have at least 9 billion inhabitants, one-third of whom will be living in India and China. The U.S. Grain Council (USGC 2011) estimates that real per capita income of the citizens of the world will increase considerably over the next 30 years, from US\$9,727 to US\$25,000. Tilman et al. (2011) estimate increases in the 2005 levels of per capita GDP for Asian nations—including the most populous countries in East and South Asia—between 2.5 and 4 times by 2050. The Asian Development Bank (ADB 2011) estimates that the middle class in China, which currently represents 12 percent of its population, could become as high as 75 percent, and that it could reach 70 percent in India and 80 percent in Indonesia by the year 2050. Parallel to this expansion, the upper classes are also expected to increase their global presence, reaching 190 million in China, 210 million in India, 40 million in Indonesia, and 35 million in the Republic of Korea. The population of Asia is expected to age considerably, reaching an estimated “over 65” cohort of 580 million, which in the case of China will represent 27 percent of all its inhabitants, a considerable change from its current level of 10 percent. The USGC study also indicates that the role of women is likely to change in important ways, with an increase in trends such as marrying at a later age or deciding not to marry at all; these trends are beginning to emerge in the wealthier Asian countries and in the Chinese middle class. Increasingly, Asian women are joining the work force, getting more education, and consequently enjoying higher incomes. Other processes, such as urbanization of the developing world (with urban concentration in China estimated to increase from 34 percent of the population in 2010 to 70 percent in 2040) and epidemiological transitions toward a greater prevalence of diseases that used to be the exclusive domain of the wealthy countries, could also have important nutritional consequences (Fan, Menon, and Brzeska forthcoming).

The obvious implication would be the increased demand for food, but there could also be important changes in composition of the diet, with a relative reduction in the demand for grains in favor of meat, fish, oils, and fruit. Conservative estimates of the annual per capita rise in consumption (of 0.2 percent) imply a 70 percent increase over current levels of consumption through 2050. The same simulations also indicate that the demand for meat, dairy products, and vegetable oils could increase more rapidly than seen in recent past decades, with fish and shellfish demand slowing down and the demand for grains growing slower than population growth.¹² So, the argument hypothesizes that the future pressure on the composition of food supply might not come from population growth alone, but from the change in preferences of the emerging population as socioeconomic equalization—that is, substantial growth of the middle class—takes place.¹³

Two considerations are important at this point. Regarding the possibility of producing enough to feed the population, East Asia is already beginning to show promising technological advances that could lead to the introduction of important improvements in agricultural production. Some of these improvements, like current climate-smart agricultural practices mentioned earlier, come either from innovation, as in the case of vertical cultivation (which would relax the severe constraints on availability of land), or from improved use of existing technology and practices, such as more economical production in terms of water, feed, or renewable energy. East Asia, and China in particular, has already implemented practices in both of these areas, as well as strong investment programs. In fact, China's 12th Five-Year Plan (2011–15) identifies biotechnology as one of the seven key industries for investment and development over the next five years. More controversial is the country's use of genetic engineering technologies that include innovative grain varieties resistant to diseases, natural disasters, and saline soils. But there is some

uncertainty around genetic engineering's repercussions on health, and its poor social acceptance is a real impediment to more decisive development in the near term. Nevertheless, society's eventual familiarization with the phenomenon—by 2050, genetic engineering technologies will have been in operation for decades—and further technological advances (such as genetic erasing) pose an interesting argument for predicting a greater role for genetic technology in future food production in Asia and the rest of the world. Once again, the extent to which these advances materialize and consolidate in the region will contribute to Asia's ability to feed its population.

The second consideration has to do with the process itself of increasing the middle class of global society, ultimately the expected key factor in the change of the relative composition of the food supply. Even though the expansion of middle classes may look like an irreversible process, evidence for Asia, particularly in China, shows that greater economic growth does not automatically lead to equalization. World Bank estimates cited at the beginning of this paper (World Bank 2012a) show that the great majority of the 649 million poor people in the world who ceased to be poor (according to the criterion of US\$1.25 per day per person) between 1981 and 2008 still continue to be poor by the standards of middle- and upper-income countries. When speaking of moderate poverty, that is, persons with incomes above US\$1.25 a day but less than US\$2 a day, progress in the last three decades has been much more modest than in the case of extreme poverty. In fact, in absolute terms, the numbers of moderately poor increased from 648 million in 1981 to 1.18 billion in 2008. In Latin America, the region that has seen the most impressive reduction in poverty, only countries like Argentina, Costa Rica, Mexico, and Uruguay have a middle class of around 50 percent of the population—measured as those earning income between US\$10 and US\$100 a day—which is far above the proportions in other countries of the region (Cárdenas, Kharas, and Henao 2011). Even more demanding figures on the expected

share of middle class in the total population are reported for Asia by 2050: 70 percent in India, 75 percent in China, and 80 percent in Indonesia after using a US\$2 to US\$4 per day, per person measure to define middle class [ADB 2011]).

Ultimately, evidence shows that the reduction of extreme poverty, as critical as it may be, does not necessarily imply an automatic increase in the middle class, much less in the magnitude needed for substantive changes to take place in the world demand for food.

5. Conclusions

Asia has seen substantial progress in the fight against hunger and malnutrition, accompanied by impressive economic growth and poverty reduction. Unfortunately, this has not been a regionwide story, but one limited to beacons of prosperity (such as China and Vietnam), alongside dismal missed opportunities (such as India and Pakistan). Economic growth alone and, more importantly, poverty reduction on its own, will not do the job of eradicating hunger and malnutrition. Nor will only the increased production of food.

A right combination of sound domestic policies and global (regional) public goods is needed—along with economic growth, poverty reduction, and increased food production. Asia is currently in a decisive position to reduce uncertainties that are affecting the levels and volatility of global food prices. It can become a leader of good policies, such as by avoiding panic behavior when agile international trade is most needed. Asia is currently developing smart agricultural practices that simultaneously improve yields, adapt better to extreme weather, and sequester greenhouse gas emissions. There are multiple examples from the region of such practices, but Asia must still

demonstrate that these are scalable beyond subnational regions. The short-term challenge is to not only strengthen the region's leadership in contributing concrete solutions on agriculture and trade policies, but also strengthen the region's safety nets and nutrition policies that help combat food insecurity.

The bottom line is that the future will see sizeable population increases and demographic changes that will affect the total demand for food, as well as the composition of that demand. Regardless of the accuracy with which current simulations project future increases in agricultural productivity and land use, ensuring that innovations are sufficiently substantial and sustained over time to meet the overall increase in demand for food by the region's growing population remains a challenge. Changes in the preferences of emerging populations will determine whether the world is capable of responding to the diversity of the new diets. But for this change in demand to happen, the reduction of poverty in the future will need to lead to the effective expansion of the middle classes and not, as has been happening up to now, simply the rise of moderate poverty.

Although this paper does not predict the future in terms of the scalability of climate-smart agriculture, biotechnology advances, social tolerance or pace of middle class expansion, this paper does emphasize that the ability of the world to produce more food should not be the only concern when addressing the challenge of feeding a growing population.

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Endnotes

¹ In the same period, the percentage of poor people in South Asia fell from 61 to 36 percent of the population. In absolute terms, 662 million people in China alone have overcome extreme poverty in the last three decades (World Bank 2012a).

² In fact, the FAO (2012b) estimates that 950 million people around the world were suffering from hunger in 2010, and of these, 578 million were in Asia. In 2011 alone, the increase in food prices added 400,000 more children to the number of those whose lives are at risk (Save the Children 2011). The emergency (and subsequent famine) in the Horn of Africa is estimated to have affected at least 13 million more people (OCHA 2011).

³ In addition, the initial levels in 1990 were so low (under 5 percent) that the target was not considered relevant in two cases, the Republic of Korea and Malaysia.

⁴ World average cereal yields growing almost perfectly linearly with annual increments of 44 kg per hectare between 1960 and 2007 imply declining yield growth rates: from 3.1 percent in the early 1960s to 2.4 percent in the early 1980s and 1.3 percent in the mid 2000s.

⁵ Improvements in global land use and manpower averaged annual return increases of 0.3 percent and 1.1 percent, respectively, since 1961 (Southgate 2009).

⁶ The USGC (2011) study predicts an increase of 53 million hectares devoted to the production of grains and oils in East Asia alone. This figure is equivalent to total land use for any type of cultivation in the last 30 years anywhere on the planet. These estimates assume that there will be relatively modest increases in productivity of at least 1 percent per year. If the productivity of grains and oils is maintained at 2010 levels, the required increase in land devoted to agriculture would be more than 400 million hectares, which is unattainable.

⁷ To be sure, even though the population increased by 70 percent, the production of calories during the same period increased by 100 percent. Tilman et al. (2011) predict an increase of 100–110 percent in global caloric demand by 2050, larger than the widely reported 70 percent. They attribute the larger increase to a closer relationship between income and dietary choices, compared with FAO’s reliance on expert opinions on national and regional trends.

⁸ See IFPRI (2008), Mitchell (2008), and Compton, Wiggins, and Keats (2011) for a comprehensive summary.

⁹ According to this hypothesis, the most widely accepted of several interpretations, at the end of 2006, food prices began to recover after decades of stagnant and declining levels. This recovery has been attributed to a number of causes, including a notable rise in the standard of living in India and China; the expanded production of biofuels, which diverts agriculture away from food production; the depreciation of the dollar; and the effects of climate change. Another sharp price acceleration took off in mid-2007 as a result of speculation; rising oil prices; the adoption of restrictive trade policies; poor management of inventories; and, ultimately, widespread panic. In this hypothesis (Timmer 2008; FAO 2007), long-term structural factors converged with unforeseeable circumstantial factors to create a perfect storm.

¹⁰ Specifically, the government gives loans to rice growers who put up their harvests as collateral, which are valued at prices well above the market. When loans come due, if the market price for rice is lower than the initial estimate, farmers are allowed to default on their loans in exchange for leaving the rice in government warehouses. In this way, the government collects large volumes of domestic rice from the growers at a subsidized price (that is, a price above the market). The export price of rice from Thailand

has risen dramatically (along with restrictions in the supply after flooding at the end of 2011), so that it costs US\$100 more per ton than competing rice from India, Pakistan, and Vietnam.

¹¹ It is unclear why these differences are so stark, but there are no systematic biases in the observed gaps.

¹² Specifically, these simulations indicate that the demand for meat could increase by as much as 201 million metric tons between 2010 and 2040 (more rapidly than the increase of 164 million between 1980 and 2010), fundamentally as a result of greater demand from China and the rest of East Asia. There could be even larger increases in the demand for dairy products, estimated at 505 million tons (compared with 305 tons in the past 30 years), again because of demand from China and the rest of East Asia, given that current levels are relatively low. For fish and shellfish, a moderate increase of 49 million tons is foreseen between 2010 and 2040, less than the increase of 67 million tons seen in the last 30 years, largely reflecting a slowdown in demand from China in a context of overfishing and current high levels of consumption. On the other hand, the increased production of vegetable oils is expected to double its rise over the last 30 years, though not necessarily led by the demand from China in this case, but rather because of strong demand in India and Africa. The consumption of grains will not keep pace with population growth: although consumption will increase in India, this will not be the case in China or the other emerging countries, which are expected to see their relative consumption decline as incomes go up.

¹³ In fact, USGC (2011) argues that increases in demand and the relative changes that result from aging or population growth itself, without any changes in people's preferences, would produce relatively modest changes in the overall demand of food.