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Meeting the global food security challenge: Obstacles and opportunities ahead

This paper introduces a special issue compiled from competitively selected, peer-reviewed papers presented at the 2nd International Conference on Global Food Security, held October 11–15, 2015, on the campus of Cornell University, in Ithaca, NY, USA. The event attracted more than 660 registered delegates from more than 60 countries. We received more than 1400 submissions for just 171 oral presentation slots arranged under 11 conference themes. Of those, 10 manuscripts made their way through multiple rounds of peer review to appear in this special issue. So this is a highly selective set of papers. Together they paint a broad picture of contemporary and pending global food security challenges, both the obstacles and the opportunities the world faces as we aspire to provide all people at all times with physical, social and economic access to sufficient, safe and nutritious food for an active and healthy life. In this brief overview, we focus on a few big food security issues from a multidisciplinary perspective that tie these papers together, encompassing agriculture, nutrition, environment, policy and the social sciences.

It is important to start by recognizing the remarkable progress made on food security in the last quarter of the 20th century, when the global food system accomplished something unprecedented in human history just as whispers of a 'population bomb' and environmental degradation were fostering grim, neo-Malthusian predictions. The number of people getting an adequate diet nearly tripled. That remarkable accomplishment goes hand-in-hand with historically unprecedented declines in global rates of extreme poverty (Chen and Ravallion, 2010). The well-documented productivity gains of the Green Revolution era played an important role in reducing the prevalence of both malnutrition and poverty (Evenson and Gollin, 2003). These accomplishments should foster hope for the future. We have faced serious challenges before and met those challenge through science because the remarkable expansion in food availability, access, utilization and stability were driven in large measure by scientific research and development, by associated extension of new scientific findings, by thoughtful policy, by the promotion of markets to facilitate lower cost delivery of increasingly inexpensive food to populations and by institutional innovations in social protection.

The progress made in food security was not without unintended consequences. Higher rates of agrochemical application with agricultural intensification increased nitrate in ground and surface waters in many areas (Galloway et al., 2003) and pesticide contamination of soil and waters (Pingali and Roger, 1995), both associated with risks to human and environmental health. Increased soil emissions of nitrous oxide (N_2O) (Forster et al., 2007) contributed to global climate forcing. Although this agricultural intensification associated with the Green Revolution of the 1970s and 1980s reportedly saved lands and the associated biodiversity and carbon storage from conversion to agriculture (Stevenson et al., 2013), there was increasing expansion (extension) of agriculture in the tropics into forests, woodlands and grasslands (Gibbs et al., 2010) with consequences to climate forcing, biodiversity, hydrological cycles, and livelihoods at the forest margins. The unintended negative environmental and social consequences of the Green Revolution era were, however, more often due not to the technologies themselves but rather to the policies used to promote rapid agricultural intensification, such as subsidies on pesticides and electricity for groundwater extraction (Pingali, 2012).

The success in addressing food security also induced complacency. Unlike their great-grandparents, relatively few consumers in high income countries worry about where their next meal will come from. As a direct consequence, political leaders began to take continued progress for granted and to falsely assume there was no longer a need to continue to invest aggressively in food systems, in the science of improving food production, processing, distribution, and nutrition, in sustaining the natural resources that support food systems, in developing the infrastructure necessary to not only achieve productivity growth but also a more equitable distribution of food. That complacency led to underinvestment, which slowed food supply growth at the same time that food demand growth accelerated quite naturally due to population and income growth.

The predictable result is that in this millennium food has grown relatively more scarce. The turn of the millennium marked the low point in food prices over the past generation. The FAO real (i.e., adjusted for inflation) food price index hit its lowest point in December 1999 (Fig. 1). Food prices remained relatively stable for several years before they began climbing relatively quickly midway through the first decade of this century. While prices have settled considerably since their December 2010 peak, average food prices over the past 10 years (to August 2016, the latest available data at the time of writing) have been 41% higher than average food prices over the decade of the 1990s and price volatility (as proxied by the six month lagged standard deviation of the series) has been 158% greater.

An era of high and volatile food prices has renewed worries about food security. High prices have been associated with food price riots and other forms of sociopolitical unrest (Barrett, 2013) and with greater transnational corporate investment in rural lands in low-income countries (White et al., 2012; Arezki et al., 2015). These various phenomena have also spurred sharply expanded donor commitments to agriculture (Swinnen and

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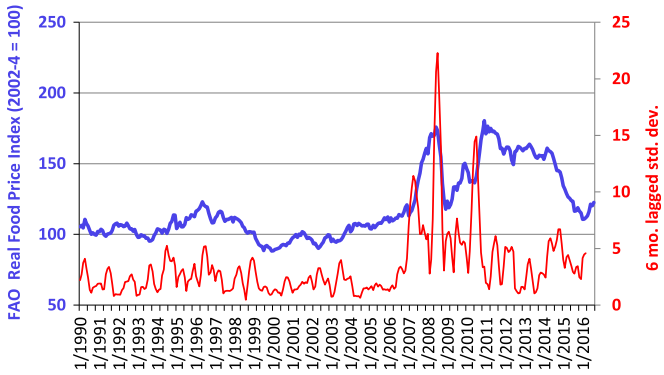

Fig. 1. Real FAO Food Price Index (2002–04=100). Average in blue, six month lagged standard deviation in red. Data source: FAO (http://www.fao.org/worldfoodsituation/foodpricesindex/en/). (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

Squicciarini, 2012). De Gorter and Drabik (this issue) argue that high food prices were related to the links between crop-biofuel price links resulting from high crude oil prices and biofuel policies. They make the case that developing country policy responses to the food price crises of 2007–12 ultimately impacted only domestic food prices, as global food prices had become intimately connected to wealthy countries' (especially the United States') biofuels policies. Their provocative argument underscores the tight and growing linkages between food markets and environmental phenomena and associated policy.

The demand-side pressures that fueled the food price rises of the past decade remain. Impending population and income growth, along with urbanization continue to drive growth in food demand. It seems unlikely that food demand growth will dampen appreciably. Population growth is a huge driver that will not slow markedly as the global headcount increases by roughly half, surpassing 11 billion people by the turn of the century, give or take hundreds of millions under the most recent, best projections (United Nations, Department of Economic and Social Affairs, Population Division, 2015). Human population is also increasingly urbanizing, especially in Africa and Asia, where most of the population and income growth will be concentrated in the decades ahead. The world just became majority urban this decade but will reach 70% by the middle of the century. An increasingly urban population means disproportionately rapid growth in demand for processed foods as well as longer supply chains and increased losses associated with more complex delivery channels.

Meanwhile, income growth remains much faster in the low- and middle-income world than it is in the advanced economies today, and the marginal demand for food out of increased income is appreciably – five to eight times – higher in low- and middle-income Africa and Asia than it is in high-income Europe and North America. Faster income growth combined with a higher propensity to spend that income growth on food products, including more animal protein together with an urbanizing population and population growth translates into significant growth in food demand in the coming decades, likely 70 or higher (FAO, 2005). And this will be an overwhelmingly African and Asian phenomenon. We must pay attention to the geography of aggregate demand growth.

Income growth and urbanization also fuel important shifts in dietary patterns, manifest in particular by the rapid rise in demand for animal products and processed foods. These demand-side drivers have major upstream implications for production patterns. For example, according to FAO data, production of fish recently surpassed that of beef. Naylor (this issue) explores how these patterns have driven the rise of aquaculture and tropical oil crops, as well as changed the relationships between multinational corporations and smallholder producers in developing countries, especially in Asia.

These same drivers – wage and income growth and urbanization – simultaneously induce important shifts in the relationship among factors of production in farming. Otsuka et al. (this issue) note how rapidly rising wages in east and southeast Asia have been slowly erasing the comparative advantage of small farmers employing labor-intensive cultivation practices and fostered the rise of (especially rental) markets in agricultural machinery. Larger farms are increasingly competitive in the region, which could lead to farm consolidation and accelerated rural-to-urban migration in the coming decades, thereby reinforcing the underlying processes driving change in the relations of agricultural production in low- and middle-income economies.

There are a few things that can be done at the margins to slow the rate of growth in food demand, such as reducing consumer food waste. Perhaps the most intriguing possibilities for attenuating demand growth arise from new insights from the behavioral sciences. As Just and Gabrielyan (this issue) explain, subtle changes in the food choice environment – often called ‘nudges’ – have been repeatedly shown to generate sharp adjustments in food consumption behavior. This is especially important in combatting the growing challenge of obesity among low-income populations. While attention remains focused especially on the longstanding challenges of undernutrition associated with insufficient energy and protein intake and micronutrient deficiencies due to inadequate mineral and vitamin availability and utilization, the world faces a rapidly expanding challenge of obesity and overweight, giving rise to a ‘triple burden of malnutrition’ (Gómez et al., 2013). So the world faces at once a significant supply-side challenge to attend to the unavoidable pressures impending due to aggregate food demand growth, while simultaneously trying to solve distributional problems that limit the access of the poor to healthy diets and promote practices that induce unhealthy and unsustainable consumer behaviors.

Since most of the demand-side drivers are either inexorable (population growth and urbanization) or desirable (income growth in Africa and Asia), attention naturally falls on the supply side of the food security equation. This is where natural resource constraints and associated environmental challenges come to bear on food security. Land constraints bind fairly tightly today, especially in Asia, Europe, the Middle East, and North Africa, limiting the options of expanding the agricultural production frontier spatially. Meanwhile in Australia, Asia and Africa water constraints are even more limiting than land availability, and likely to be aggravated by climate change. As Campbell et al. (this issue) explain, we are already seeing the adverse impacts of climate change on crop, fisheries and livestock quality and quantity. Agriculture already accounts for more than 70% of human water use and more than 80% in the two continents where demand growth is going to be concentrated, Africa and Asia (FAO, 2008). So there is scant capacity to put much more land or water into agricultural production over the coming generation. And we have no option to move more of the harvest to sea. The marine capture fisheries are increasingly exhausted; sustainable yields have been reached or exceeded in more