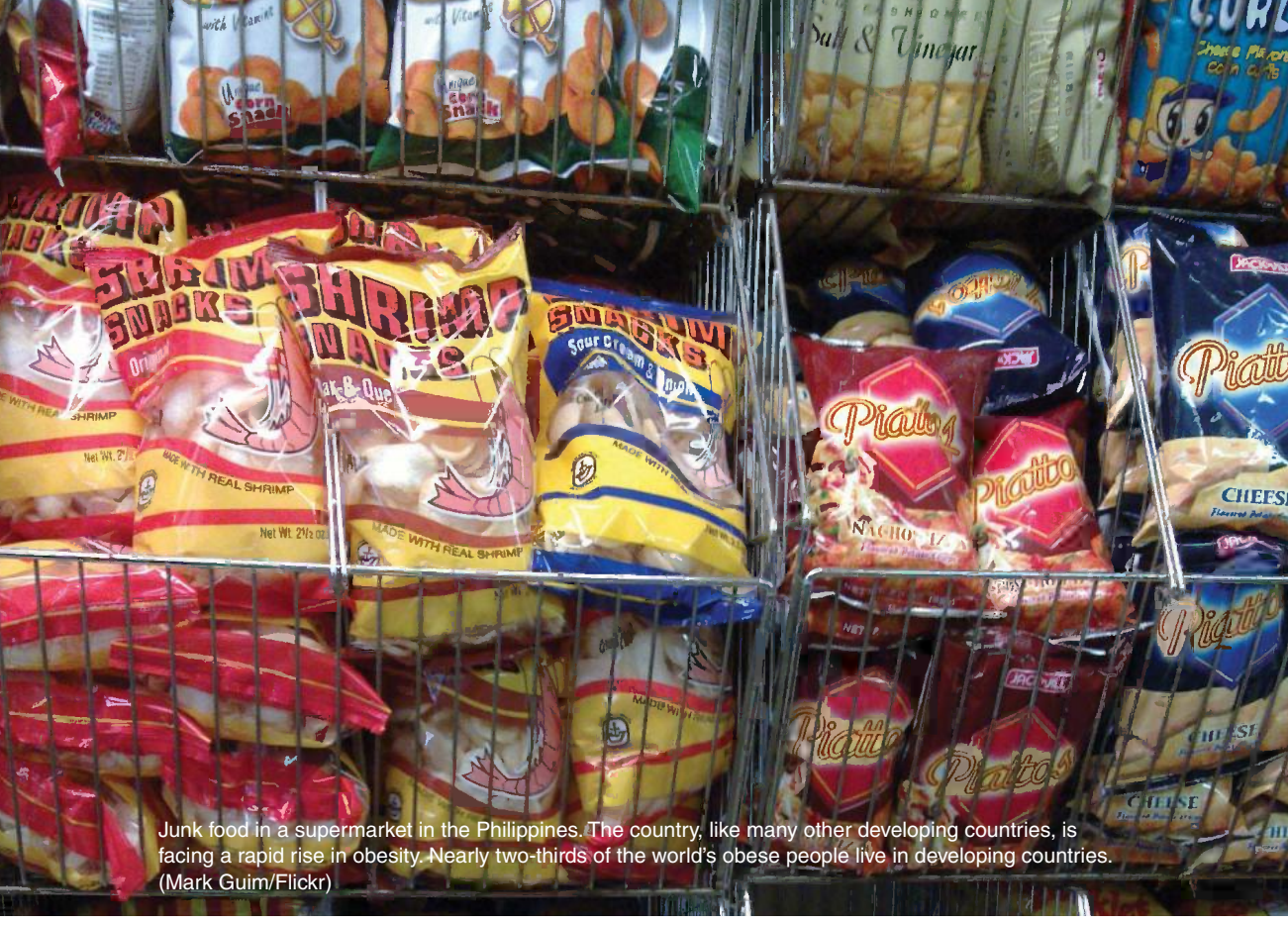

Junk food in a supermarket in the Philippines. The country, like many other developing countries, is facing a rapid rise in obesity. Nearly two-thirds of the world's obese people live in developing countries. (Mark Guim/Flickr)

8

Reshaping Agriculture to Reduce Obesity

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 Agriculture for Improved Nutrition: Seizing the Momentum
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Introduction

The world is faced with a growing obesity epidemic that has critical implications for individual health, household wealth, and social and economic development. In 2013, more than 2.1 billion people, equivalent to 30% of the world's population, suffered from obesity or overweight – the precursor to obesity (Ng *et al.*, 2014). While trend estimations suggest that increases in the prevalence of obesity among adults and children will eventually attenuate in most high-income country (HIC) regions, it will continue at current rates or even accelerate in all low- and middle-income countries (LMIC) regions (Ng *et al.*, 2014; NCD Risk Factor Collaboration, 2017). Already today, almost two-thirds of the world's obese population live in LMICs. Although the prevalence of obesity has been lower among children than among adults, the rate of increase in childhood obesity since the 1980s has been greater than that in adulthood obesity in many countries around the world, especially LMICs (GBD 2015 Obesity Collaborators, 2017).

This chapter provides an overview of the global burden of the growing obesity epidemic and reviews regional trends in macronutrient availability. It then presents drivers of food overconsumption and explains the likely contribution of agriculture to the growing obesity epidemic in LMICs. The chapter concludes by discussing key challenges to reforming agricultural policies for reducing obesity and the potential contribution of food policy research.

Global Burden of the Growing Obesity Epidemic

Obesity considerably increases the risk of several non-communicable diseases (NCDs) such as cardiovascular diseases (like heart attacks and strokes), type 2 diabetes mellitus, and hypertension. According to the 2016 Global Burden of Disease (GBD) study, 72% of all cause-specific deaths worldwide are from NCDs, while the leading causes of total years of life lost are cardiovascular diseases, accounting for 45% of all NCD-caused deaths (GBD 2016 Causes of Death Collaborators, 2017). The global death rate from cardiovascular diseases increased by 15% between 2006 and 2016. Most of the global burden of deaths and disabilities from these NCDs occurs in LMICs mainly because of the large contribution of modifiable risk factors and limited capacities for effective treatment (Wagner and Brath, 2012; Feigin *et al.*, 2016; GBD 2016 Causes of Death Collaborators, 2017). Moreover, the health literature provides robust (suggestive) evidence that fetal undernutrition increases the risk of obesity and associated NCDs later in life (e.g. Barker, 2004; Bhargava *et al.*, 2004; Uauy *et al.*, 2008; Koletzko *et al.*, 2012).

The 2016 GBD study found that high body-mass index (BMI), poor dietary habits, and (likely related) high systolic blood pressure and high fasting plasma glucose rank among the leading modifiable risk factors of attributable deaths and disabilities globally (GBD 2016 Risk Factors Collaborators, 2017). Poor dietary habits refer to consuming unbalanced and unhealthy diets such as diets that are low in vegetables, fruits, pulses, and whole grains and high in red and processed meat, hydrogenated vegetable oils, sugar-sweetened beverages, and sweet and salty snacks. These diets tend to be poor in essential bioavailable micronutrients (minerals and vitamins) and fiber and rich in unhealthy components such as bad cholesterol, saturated and trans fats, and sodium, in addition to being dense in dietary energy (measured in calories). Alarmingly, shifts in patterns of diets toward the consumption of obesogenic foods (which are dense in calories and usually poor in fiber and micronutrients) and nutrition-related NCDs toward obesity-associated diseases in LMICs appear to occur generally at greater speed and earlier stages of economic and social development than in today's HICs at similar development stages in the past (Popkin, 2002).

The growing obesity epidemic has high direct costs for public and private health care budgets, given high treatment costs for associated NCDs (Colditz, 1999; Sassi, 2010). However, the indirect economic costs are often far more important and include costs incurred by reduced labor productivity, work absenteeism, early retirement, disability, and premature mortality (Popkin *et al.*, 2006; Trogdon *et al.*, 2008; Dee *et al.*, 2014). These costs can affect economic growth, especially in labor-intensive economies found in many LMICs. For example, the direct annual costs attributable to overweight and obesity in China are

estimated at around US$6 billion and expected to rise by less than 5% between 2000 and 2025 (Popkin *et al.*, 2006). The indirect costs are estimated at about US$44 billion in 2000 and are expected to rise by more than 140% to US$106 billion in 2025. Hence, the total costs of overweight and obesity in China accounted for an estimated 4.1% of the country's gross national product (GNP) in 2000 and an estimated 9.2% of GNP in 2025 (Popkin *et al.*, 2006).

Regional Trends in Calorie and Animal Protein Availability

The obesity epidemic and the associated NCD burden are direct consequences of diets. Rising BMI and increasing prevalence of obesity in a population can be driven either by increasing energy intakes, decreasing energy expenditures, or a combination of both. Using historical data from mostly HICs, Bleich *et al.* (2008) estimated the relative contribution of increased energy intake and reduced physical activity to obesity. The study results showed that the energy imbalance and increasing obesity in recent decades were primarily driven by consuming more calories – at least in the developed world. Similar exploratory studies for LMICs are lacking, possibly because of lack of historical data on physical activity levels. Generally, obesity tends to be less prevalent in rural areas than urban areas, because food options in rural areas are typically less varied and accessible than in urban areas; and physical activity levels are higher due to manual labor-intensive economic activities and lower use of motorized transportation (Malik *et al.*, 2013). The rural–urban differences in dietary and activity patterns tend to shrink with expanding infrastructural development and advancing economic transformation in rural areas (Popkin, 1999).

It should be noted that there is no physiological adjustment process whatsoever to mitigate the effects of energy imbalance on body composition. The portion of the human genome that determines basic anatomy and physiology has remained relatively unchanged since the Stone Age (Eaton *et al.*, 1988; Larsen, 2015; Cordain *et al.*, 1998). Hence, the complex interrelationship between energy intake, energy expenditure, and specific physical activity requirement for current humans remains very similar to that of hunter-gatherers and the first agriculturalists, whose physical activity patterns were very high compared to those of most people today.

The global supply of calories per capita increased by 13% from the early 1980s to the early 2010s (Table 8.1). The three-year average in 2011–2013 exceeded 2800 kcal/day globally and in all HIC-dominated sub-regions and half of all LMIC-dominated sub-regions across the world. Among these sub-regions, the increases in per capita calorie supply from the 3-year average in 1981–1983 were highest in Eastern Asia (29%), Northern Africa (19%), and North America (15%). These sub-regions also showed the largest absolute increase in the number of children and adolescents with obesity (NCD Risk Factor Collaboration, 2017). The trend in these sub-regions are largely driven by one populous country in each of the regions, namely China, Egypt, and the USA, respectively. Egypt and the USA have among the highest prevalence rates of obesity worldwide. Astonishingly, obesity among both women age 20 years and older and girls younger than 20 years is more prevalent in Egypt than the USA (48% and 14% compared with 34% and 13%, respectively) (NCD Risk Factor Collaboration, 2017).

Globally and in most geographical regions and sub-regions of the world, animal protein supply is highly correlated with calorie supply. The global supply of animal protein per capita increased by 36% from a 3-year average of 23.5 g/day in 1981–1983 to 32.0 g/day in 2011–2013 (Table 8.1). Some sub-regions have experienced particularly rapid increases in animal protein supply. For example, during the three-decade period, the animal protein supply increased by more than threefold in Eastern Asia and by more than twofold in South-eastern Asia. Rising consumption of animal products such as red meat, whole-milk dairy products, and eggs increases the risk of nutrition-related NCDs, as these foods are high in saturated fats and cholesterol in addition to protein (GBD 2016 Risk Factors Collaborators, 2017).

Drivers of Overconsumption in Low- and Middle-Income Countries

The rapid increase in food overconsumption and resulting obesity and associated NCDs in LMICs

Table 8.1. Calorie and animal protein supply by geographical regions and correlations (own estimation based on FAO (2017) data).

	Calorie supply per capita			Animal protein supply per capita			Correlation	
	Average (kcal/day)		Change	Average (g/day)		Change	Annual (1981–2013)	
	1981–83	2011–13	(%)	1981–83	2011–13	(%)	Coef.	Sign.[a]
World	***2536***	***2876***	***13***	***23.5***	***32.0***	***36***	***0.99***	***
Africa	*2232*	*2619*	*17*	*13.2*	*16.1*	*22*	0.85	***
Eastern Africa	2061	2167	5	10.2	10.2	0	0.51	***
Middle Africa	1960	2395	22	13.9	15.5	12	0.37	**
Northern Africa	2710	3216	19	15.2	26.5	74	0.96	***
Southern Africa	2785	2925	5	24.9	33.4	34	0.84	***
Western Africa	1934	2687	39	11.8	12.5	6	0.42	**
Americas	*2884*	*3226*	*12*	*43.7*	*51.8*	*19*	0.98	***
Northern America	3185	3654	15	65.9	68.3	4	0.87	***
Central America	2904	2924	1	26.6	36.1	36	0.74	***
Caribbean	2537	2711	7	25.6	25.2	–1	0.73	***
South America	2603	3022	16	29.4	46.3	58	0.97	***
Asia	*2280*	*2768*	*21*	*11.3*	*26.4*	*133*	0.99	***
Central Asia		2794			36.0		0.74	***
Eastern Asia	2373	3057	29	12.6	39.5	214	0.51	***
Southern Asia	2133	2472	16	8.4	14.0	66	0.91	***
South-Eastern Asia	2166	2701	25	11.3	24.3	115	0.99	***
Western Asia	3087	3150	2	26.8	30.9	15	0.59	***
Europe	*3317*	*3366*	*1*	*54.8*	*57.9*	*6*	0.92	***
Eastern Europe	3357	3290	–2	51.1	51.2	0	0.92	***
Northern Europe	3115	3387	9	55.7	61.9	11	0.90	***
Southern Europe	3293	3335	1	50.8	59.0	16	0.32	*
Western Europe	3348	3497	4	65.5	65.3	0	0.08	
Oceania	*3019*	*3201*	*6*	*65.9*	*66.4*	*1*	0.38	**
Australia and New Zealand	3064	3237	6	69.0	69.1	0	0.42	**
Melanesia	2431	2766	14	29.3	30.9	5	0.24	
Micronesia	2772	3041	10	27.3	36.7	34	0.73	***
Polynesia	2621	2932	12	35.2	59.4	69	0.83	***

[a] ***, **, * Correlation coefficient is statistically significant at the 1%, 5%, and 10% level, respectively.

may be largely explained by a combination of three key drivers: (i) economic growth (along with urbanization); (ii) decline in real food prices and relative price changes; and (iii) changes in the global food system (e.g. FAO, 2004; Popkin and Gordon-Larsen, 2004; Popkin, 2006; Prentice, 2006; Swinburn *et al.*, 2011).

Economic growth tends to increase real household incomes, including among the poor. As a consequence, a growing number of people can afford to increase their consumption. Globally, annual GDP per capita has been highly correlated with annual calorie and animal protein supplies per capita (Fig. 8.1). Average GDP per capita growth in LMICs has been positive since 1984 (except for 1991–1992) and has accelerated since 2000.

In addition to increases in total calorie consumption, economic growth is associated with shifts in the composition of total calories consumed (Popkin and Gordon-Larsen, 2004). Globally, as countries have become more urbanized, the share of calories from animal fats and animal protein have drastically increased and the share of calories from carbohydrates and vegetable fats have declined with growing national income; the share of calories from vegetable fat has been constant. At the same national income level, the share of calories from animal fat has increased faster in more urbanized countries than in rural-dominated countries. Among the share of calories from proteins, there has been a proportional substitution of vegetable protein by animal protein (Drenowski and Popkin, 1997).

A decline in real food prices and relative price changes has also been a driver in food overconsumption, obesity, and associated NCDs in LMICs. Global food prices in real terms steeply declined in the 1970s and early 1980s and stabilized at a low level for two decades until the mid-2000s (FAO, 2017). Thus, in addition to rising incomes, declining and stably low food prices helped make food more affordable. Yet, price changes have not been uniform across foods (Delgado, 2003). For example, the real prices of the most common cereals (wheat, maize, and rice) declined by about 50% globally between 1970–1972 and 1996–1998 (Fig. 8.2). The real beef price dropped by 68% and the real milk price declined by 40% globally during this 25-year period. Comparable global price data for vegetables and fruits are unavailable, because vegetables and fruits commonly consumed locally are hardly traded globally. However, changes in domestic real prices of vegetables and fruits can be expected to be nowhere near the declines in (domestic) real prices of cereals and animal products. These relative price changes incentivize consumers to increase their consumption of the cheaper food items and partially substitute (relatively) more expensive food items. Thus, the costs of a diet dense in calories (sourced mainly from staple foods, mostly cereals) and rich in animal protein (sourced mostly from meat) declined rapidly throughout the 1970s, 1980s, and 1990s, whereas the costs of a diverse diet rich in a variety of essential micronutrients may have declined only marginally, if at all.

Changes in the global food system have also played a part in the rise in obesity. The integration of LMIC economies into the global food system through trade liberalization and opening of domestic markets for foreign investors has led to a rise in imported, highly processed, and obesogenic foods and beverages such as fast food, sugar-sweetened drinks, and fatty and salty snacks, often provided by multinational companies (Hawkes, 2005; Rayner *et al.*, 2006; Swinburn *et al.*, 2011). For example, Coca-Cola offers nearly 3900 beverage products in over 200 countries (Coca-Cola, 2018) and McDonald's has more than 36,000 restaurants in over 100 countries (McDonald's, 2018). Many local restaurants and chains have attempted to copy these American fast-food models and their products (Popkin, 2006). The consumption of obesogenic foods and beverages has been aggressively advertised in LMICs through global mass media and roadside billboards, among others. Evidence suggests that children's exposure to obesogenic food and beverage advertisements on television is linked to excess body weight (Lobstein and Dibb, 2005; Lobstein *et al.*, 2015). Globalization and technological innovations (in communication and logistics, for example) in combination with urbanization and affordable motorized transport have also contributed to the rapid spread of multinational and local supermarkets and hypermarkets (Reardon *et al.*, 2003; Mendez and Popkin, 2004). Evidence from urban Kenya, for example, suggests that shopping in supermarkets increases adults' BMI and the risk of overnutrition-related NCDs (Demmler *et al.*, 2017, 2018).

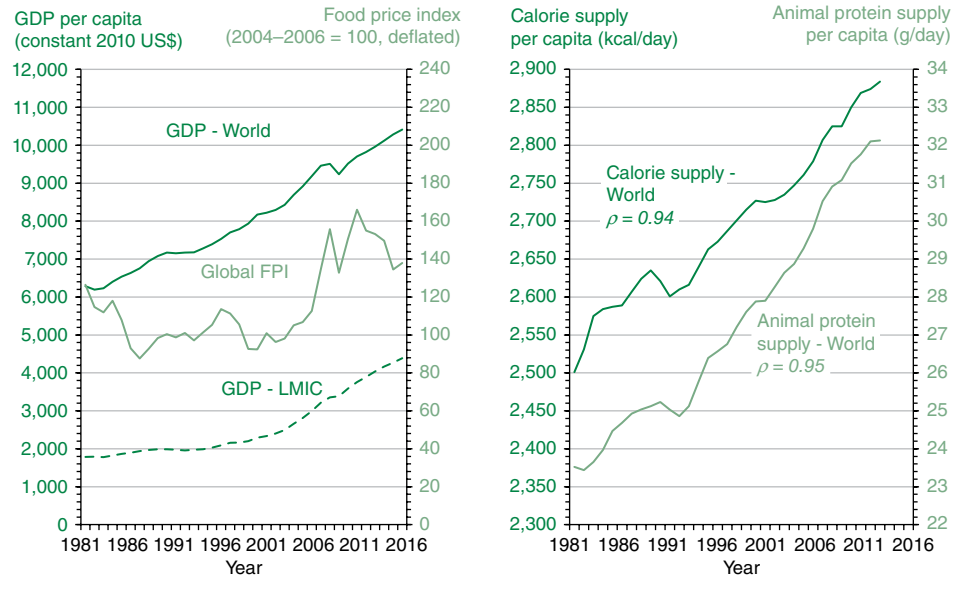

Fig. 8.1. Global economic growth, food prices, and calorie and animal protein supply. Own representation based on World Bank (2017) and FAO (2017) data (ρ = coefficient of correlation with GDP per capita – World).

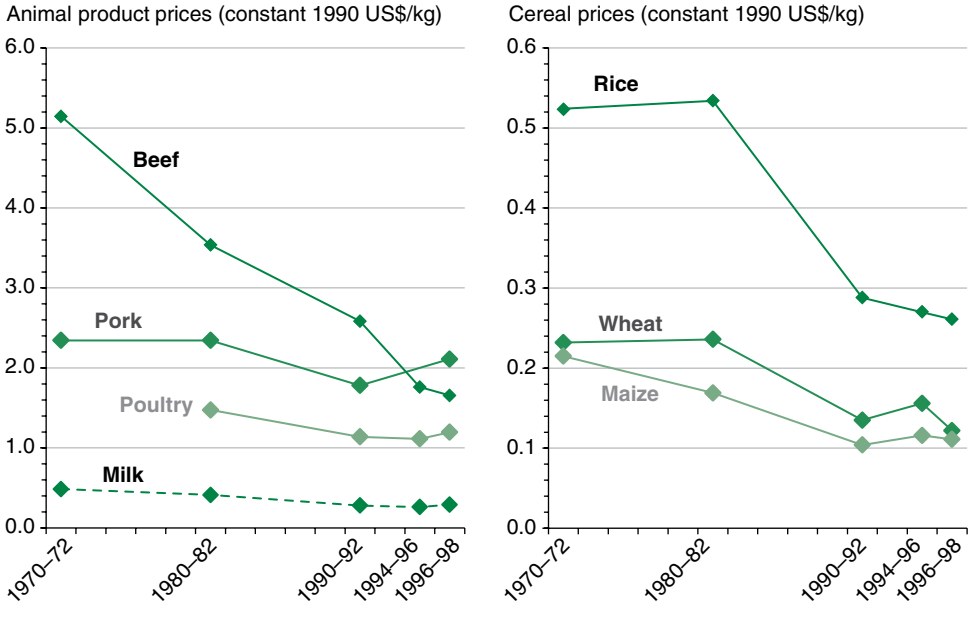

Fig. 8.2. Global prices of cereals and animal products in real terms. Own representation based on data from Delgado *et al*. (2001).

Agriculture's Contribution to the Growing Obesity Epidemic in Low- and Middle-Income Countries

Agriculture and particularly the agricultural and technological revolutions of the late 20th century have likely contributed to the growing obesity epidemic in LMICs in at least four ways.

First, agricultural productivity growth, most notably thanks to the Green Revolution, has contributed to – but has not driven – overall economic growth. Agriculture's average value added to GDP in LMICs steadily declined from around 30% in the late 1960s to around 23% in the early 1980s and below 10% in the late 2000s (World Bank, 2017). Nevertheless, improved agricultural technologies and practices have substantially increased yields of staple crops, especially of the most common cereals, and also led to increased farming incomes (Evenson and Gollin, 2003; Pingali, 2012).

Second, increases in agricultural productivity and outputs have reduced and stabilized real food prices and hence lowered the overall costs of diets for the wider population, as discussed earlier. As productivity gains have differed across crops, so have the rates of price reduction. For example, average yields for all LMICs rose 208% for wheat, 157% for maize, 109% for rice, 78% for potatoes, and 36% for cassava between 1960 and 2000 (Pingali, 2012). These yield increases have not translated into proportional consumer price reductions partly because maize (in addition to soybean) and, to a lesser extent, wheat are also the most important livestock feed grains. The reduction in producer prices for these grains has been partially transmitted into the sharp declines for animal products over past decades (Fig. 8.2) (Delgado, 2003).

Third, agricultural mechanization and increased affordability of motorized transport have reduced the physical workload of farmers and shortened the worktime of farming and agricultural marketing activities (Prentice, 2006; Swinburn *et al.*, 2011). Time savings have been devoted partly to increased leisure time dominated by sedentary activities. These shifts in farmers' physical activity patterns have reduced their energy expenditures, though data on the contribution of agricultural mechanization to energy use is not available.

Fourth, and most critical, the agricultural and food policy environment and especially distortions to agricultural incentives due to government actions in both HICs and LMICs have likely contributed to the growing obesity epidemic in LMICs (Schäfer Elinder, 2005; Hawkes *et al.*, 2012, 2015). Policies that promote directly the production of specific crops or livestock products, such as input subsidies and output price supports, affect domestic food supply and (relative) food prices to which consumers' food demands respond. Similarly, policies that promote agricultural technology adoption, mechanization, and irrigation infrastructure – even if they are non-product-specific or distortive – have differential effects on food production and relative food prices, because improvements in these production factors tend to benefit the production of specific crops or livestock and its scalability. Among food products, agricultural subsidies and other agricultural support policies have mainly been targeted to promote the production of the most common cereals (wheat, maize, rice) and meat and dairy products (Anderson, 2009). Other non-agricultural interventions that nevertheless impact agricultural outputs and consumer food choices include measures at the country's border (such as import or export taxes, price support, and quantitative restrictions) and measures in domestic food markets (such as food price subsidies and taxes and food assistance programs). Agricultural input subsidies, output price protection, and import taxes and restrictions were popular policy instruments to facilitate the Green Revolution in Asia and Latin America and hence to achieve the agricultural productivity gains in past decades mentioned above (Pingali, 2012). Finally, agricultural policies in large exporting countries may also affect food supply and pricing in importing countries by influencing world market prices and exploiting bi- or multilateral trade agreements (such as in the case of European Union's exports of poultry and dairy products to African countries).

Distortion to Agricultural Incentives and Consumption Effects

From the early 1960s to the early 1980s, farmers in LMICs were increasingly taxed directly

through taxes on exportable goods and, more so, indirectly through the effects of current national account deficits and industrial protection policies (Krueger *et al.*, 1988). This trend gradually reversed and, since the mid-1990s, resulted in positive aggregate support to farmers (Anderson *et al.*, 2009). In HICs, aggregate support to farmers rose steadily from the 1950s to the early 1990s, before declining, especially when world food prices shot up (Anderson *et al.*, 2009). Nevertheless, government support to farmers has remained much higher in HICs than LMICs.

Anderson and Valenzuela (2008) and Anderson and Nelgen (2013) measured national annual distortions to agricultural incentives for all major agricultural products using the nominal rate of assistance (NRA) – the percentage by which government policies have raised gross returns to farmers above what they would be without the government's interventions (or lowered them, if the NRA is less than zero) (Anderson *et al.*, 2009). Unfortunately, consistent national time-series data are unavailable for this analysis.

Figure 8.3 presents NRA estimates for main foods for LMICs in Africa, Asia, and Latin America and Caribbean, altogether and by region, and for HICs. The selected foods are the top eight agricultural products with the highest gross subsidy equivalent from 1980 to 2009. The NRA by country group is derived from annual, country-level estimates and should be interpreted as averages for groups of selected, important countries rather than regional averages.

Figure 8.3 shows that the eight agricultural products with the highest gross subsidy equivalent globally include the most common cereals (wheat, rice, maize), sugar, and animal-source foods (poultry, pork, beef, milk). Although average NRAs for all eight foods in HICs were considerably lower in the 2000s than the 1980s and 1990s (except for pork), they remain much higher than the respective average NRAs in LMICs. Throughout the 1980s, 1990s, and 2000s, the NRAs in HICs were highest for rice, sugar, and milk. HIC exports of the supported products to LMICs have distorted the prices in the importing LMICs, if they have no HIC NRA-equivalent import taxes in place. Hence, agricultural subsidies and other support measures in HICs have likely contributed to reduce (relative) prices of these foods faced not only by their own populations but also by the LMIC populations.

In LMICs, the shift from overall discrimination against agriculture up to the 1980s to positive aggregate support to farmers since the 1990s was partly driven by reversing agricultural disincentives for the production of the main domestic staple food crops and pork in Asia and Latin America and Caribbean and sugar production in Latin America and Caribbean due to fundamental changes in national agricultural and trade policies (Fig. 8.3). Average NRAs for sugar increased from the 1990s to the 2000s in all three LMIC regions. In contrast, average NRAs for milk were considerably lower in the 2000s than the 1980s and 1990s in Asia and Latin America and the Caribbean and even negative in the 1990s and 2000s in Africa. The largest government support over the three-decade period was received for the production of sugar in Africa; beef, milk, and sugar in Asia; and milk in Latin America and the Caribbean. However, the (positive) average distortion in all three regions was far below that in HICs for any of the eight foods and during any of the three decades (except for beef in Asia).

Government support for producing staple foods, sugar, and animal-source products such as input subsidies and output price protection incentivizes farmers to increase production of these products relative to non- or less supported foods such as vegetables, fruits, and pulses. This tends to translate into lower prices of the supported foods absolutely or relative to other foods. Consumers, particularly the poor, respond to these price signals by consuming more of staple foods, sugar, and – if at all affordable – animal-source foods and less of more nutritious foods such as vegetables, fruits, pulses, and fish, increasing the risk of obesity and insufficient dietary diversity. A typical case is Egypt, where input subsidies and output price protection for the production of main staple crops (wheat, maize, rice) and sugarcane also serve to supply the enormous national food assistance program at low costs. Findings from a recent study suggest that the program contributed to the extreme prevalence of obesity likely by lowering the costs of a calorie-dense diet relative to a more diversified diet (Ecker *et al.*, 2016).

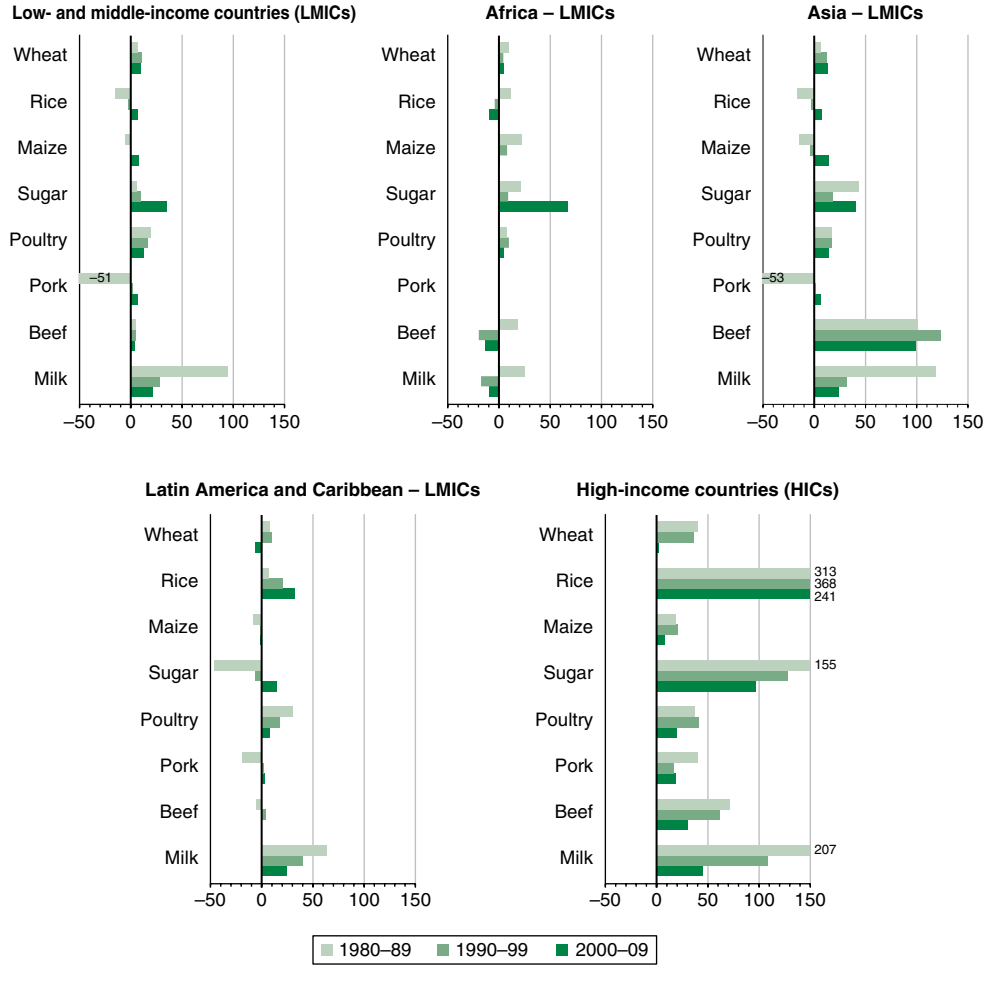

Fig. 8.3. Decade-average nominal rate of assistance (NRA) by region. Own estimation based on data from Anderson and Nelgen (2013). (The country samples partly vary by product. This list of included countries can be received from the author upon request.)

Conclusions

Reforming agricultural policies in both HICs and LMICs to reduce or ultimately eliminate distortions to agricultural incentives that tend to lower the costs of a calorie-dense and animal protein-rich diet relative to a more diversified diet is likely to be an important contribution to alleviate the growing obesity epidemic in LMICs. Many of the agricultural policies in LMICs that promote staple food and livestock production for household food security and national food self-sufficiency stem from an era when undernourishment (in terms of energy intake) was the prime nutrition problem. This has changed in most LMICs. Hence, it is time for national agricultural policy to address new nutritional challenges.

Yet, current agricultural subsidies and other support to farmers have often a social protection objective in addition to the agricultural production objective, as farmers make up a large share of the poor population. Cutting agricultural subsidies may therefore lead to real income losses for farmers, if no compensation mechanism is in

place. Moreover, input cost subsidization and output price protection for key food crops (sometimes referred to as 'strategic crops') are often intertwined with government social protection programs such as household food assistance and school feeding programs. Moving from a food-based support system to a cash-based support system may hence help to implement fundamental agricultural policy reforms.

Reforming agricultural policies for improved nutritional outcomes, however, is faced with critical knowledge and data gaps, especially in LMICs. For example, rigorous studies that analyze the dietary and nutritional impacts of specific agricultural policies are scarce and lacking for Africa and the Middle East. Moreover, existing studies that advise agricultural policies on nutrition-sensitivity tend to fall short on examining the costs and benefits associated with the recommendations made. Research is also limited by vast gaps in (publicly) available data. For example, most LMIC governments do not publish (or even document) national expenditure data disaggregated by specific agricultural investments and programs on an annual basis. Global and national horticultural price data for the most important vegetables and fruits are missing, and available production data are usually of poor quality. Narrowing these knowledge and data gaps ought to be a priority of food policy research.

The potential contribution of reshaping agriculture to reduce obesity in LMICs may be more limited than the potential contribution of changing established practices in other sectors of the food system such as in food processing, marketing, retail, and services. Nevertheless, agricultural policy reforms are needed in many LMICs to restore the sector's competitiveness, which provides a unique opportunity to enable the agricultural sector to contribute its share. Research can play an important role to make agriculture more nutrition-sensitive by helping policy makers in evidence-based decision making in reforming outdated and nutritionally adverse agricultural policies.

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