

# Agricultural policies, food and public health

**SSS** Science & Society Series on Food and Science

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What and how much we eat and drink has a significant influence on our health. This is evident in the epidemic of obesity sweeping across developed and developing nations alike, bringing in its wake a range of diseases including diabetes, coronary heart disease and some cancers. One main cause of this is a change in diet that has directly affected our health and well-being. For more than a century, Western governments have invested heavily in agricultural research and infrastructure with the aim of providing sufficient, affordable animal products and some basic cash crops. Accordingly, Western diets have shifted over the past century, in particular during the period following the Second World War, to include more animal-sourced foods—such as meat, poultry, dairy products, seafood and eggs—as well as more refined carbohydrates—that is, caloric sweeteners from a range of food crops including sugar cane, sugar beets and corn. During this same period, however, we have begun to realize that a healthy diet actually requires fewer animal products and refined carbohydrates and more vegetables, fruits, beans and whole grains. Redressing this balance is a complex task requiring not only a shift in agricultural investment and policy, but also changes in social preferences that have developed over decades, in part due to the relative cheapness of animal-sourced foods.

Many groups offer specialized perspectives on food; 'locavores' and the slow food movement, public health advocates who want to ban sugar-sweetened beverages and other 'junk' or low-nutritional-value food, economists, agricultural scientists and other experts. My perspective as a global nutrition

scientist and human-resource economist is to analyse the forces that have shaped our food supply in order to understand what we habitually eat and drink today. This could help to understand what it might take to improve imbalanced diets and recapture earlier and healthier eating patterns. It is therefore instructive to look at food, agriculture and diets from a historical perspective, as our health requirements and our understanding of the role of diet in health is different from earlier periods.

**Focusing on sugar and spices provides a useful example with which to begin the story of how our agricultural system and social preferences have evolved**

The discovery and exploration of the Americas—the New World—was driven by a desire to find faster and more efficient routes to the spice islands of Asia—the Old World—thereby circumventing the Muslim empires. In the course of this endeavour, the great European explorers first discovered and mapped the Caribbean islands, North and Central America and, eventually, the whole of the Americas. The economic exploitation of the Caribbean and what is today the USA began with sugar plantations and trade in rum and molasses—the search for gold started later (Fig 1).

Focusing on sugar and spices provides a useful example with which to begin the story of how our agricultural system and social preferences have evolved. Both of these commodities have had an important historical role in the rise and fall of empires

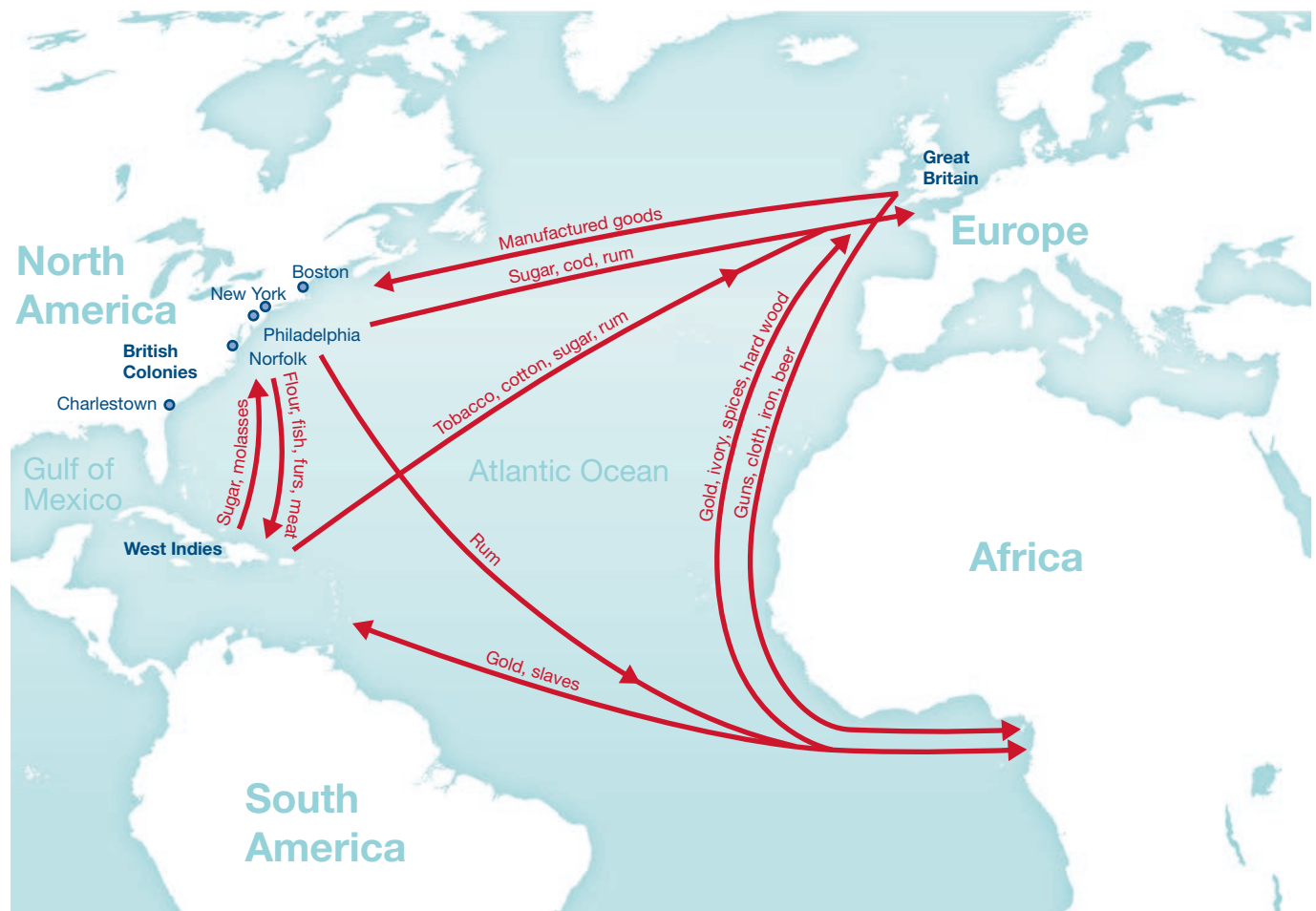
and, in some sense, between the fifteenth and nineteenth centuries sugar and spices dominated global trade. As an example of the importance of spices, the Dutch traded the island of Manhattan to the British in return for the island of Run in the Indonesian Banda Islands, where nutmeg was grown (Fig 2). Together with cod, sugar and spices drove nations to war and created the largest food-related conflicts of that period. During the seventeenth century alone, the trade of spice and sugar in the New and Old Worlds triggered violent clashes over territories and trade routes (Corn, 1998; Schwartz, 2004). By the end of the 1600s, European powers had managed to gain control of the global production and trade of these foods, with each country exploiting foreign resources and labour for their own wealth.

Nevertheless, the importance of these agricultural commodities to Europe both expanded production in the colonies and boosted research. Indeed, modern agricultural research was enabled by the work of scientists in the nineteenth century such as Justus von Liebig (1803–1873) in Giessen, Germany, who founded agricultural chemistry—in particular the use and effects of



## Science & Society Series on Food and Science

This article is part of the EMBO reports Science & Society series on 'food and science' to highlight the role of natural and social sciences in understanding our relationship with food. We hope that the series serves a delightful menu of interesting articles for our readers.



**Fig 1** | The Atlantic trade routes between Africa, the New World and Europe. The ‘trade triangle’ was appealing to European (particularly British) merchants because each leg of the journey was profitable. Manufactured items such as guns, alcohol or cloth could be shipped to Africa, the traders would then pick up slaves to take to America and the West Indies, before finally returning to Europe with highly profitable food and raw materials including cod, sugar and molasses—which could be processed into rum.

fertilizers—and Gregor Mendel (1822–1884), whose work on inheritance laid the scientific foundation for modern crop-breeding programmes and the field of genetics. Today, Giessen University has a museum about the origins of organic chemistry and the birth of modern fertilizer and, as an aside, the discovery that led to Marmite™—much favoured in Britain and by many vegetarians (von Liebig, 1840). It was the work of these scientists and the contributions of others over the ensuing decades that eventually created the modern agricultural system (Gardner, 2002).

In my quest to understand the history of agriculture and how government investment in food and research has shaped our diet, I have focused on the USA, which put forth its first systematic funding programme

for agriculture in 1862. Sugar was one of the first crops to benefit from government money and by 1878 this investment had resulted in the successful cultivation of sugar beets in Maine and the first beet-sugar factory in California, only one year later. Outside the USA, research was funded to systematically increase the productivity of sugar plantations in the Caribbean and Indonesia. Cane-breeding research began in the 1880s in Java, at the Dutch East Java Research Station and in Barbados, at the British Dodds Botanical Station (Galloway, 1996, 2000).

Many will argue that direct government support for farmers in the USA occurred mainly after the Second World War, but we should not dismiss the importance of earlier developments (Agricultural Research Service, 2007). These include the creation of

the US Department of Agriculture in 1862 by the Abraham Lincoln administration, the authorization of public land grants for colleges to teach agriculture, the instigation of government research on animal diseases, the development of an array of agricultural cultivation techniques and tools, the import of Aberdeen Angus bulls from Scotland in 1873, the creation of feed mills and milking machines, the irrigation of arid lands, the first long-haul shipments of meat in refrigerated boxcars in 1888... we could go on.

Another issue was the use of nitrogen fertilizers and the concomitant breeding of crops that were better suited to using it. Moreover, the development of hybrid corn, rust-resistant wheat and oats and insect-control programmes increased the production of feed for the livestock industry. Artificial insemination,



**Fig 2** | Purchase of Manhattan Island by Peter Minuit, September 1626. Oil on canvas by American School (Twentieth century). © Collection of the New York Historical Society, USA/ The Bridgeman Art Library.

controlled feeding, cross-breeding and disease control improvements for livestock, poultry and the dairy industry were all also developed in the 40 years before the war (Gardner, 2002). Finally, sugar remained an important commodity: for example, the Sugar Station—founded in 1885—is the oldest of the Louisiana Agricultural Experiment Stations.

The agricultural sector undoubtedly had a crucial role in the development of the US economy and society. Railways to transport livestock, among other things, opened up the US mid-west and canals were built to move grain. During the nineteenth century, the majority of American workers were farmers and, although their numbers have declined during the twentieth century, they have retained their voice and influence; not only on the economy and politics, but also on the American psyche.

The key issue with all of these developments is that much of the government

**The Soviet government strongly emphasized competition with the West, not only in space technology and science, but also in terms of diet and health**

funding and research focused on a few cash crops, particularly grains and animal-source foods. From 1850–1950, this focus was a result of politics and science and the most important economic crops received the greatest government support. However, despite the enormous advances between 1870 and 1945, there was actually little increase in the yield of key crops such as corn, wheat, potato and cotton (Cochrane, 1993).

**A**t the same time, nutritionists and other experts were beginning to take a closer look at diets, with the aim of improving health. Wilbur Olin Atwater (1844–1907), Carl Voit (1831–1908)

and other scholars in the 1800s called for improvements in the diets of labourers, soldiers and workers in Western Europe and the USA, to include 100–200g of protein each day. Studies in mice and other animals supported this recommendation, as animals that were fed more protein grew better. During this period, most medical and nutritional research therefore recommended an adequate supply of grains and other basic staples and encouraged the consumption of animal products, as the focus was on protein quality. Rare was the scientist, such as Weston Price, whose studies of isolated indigenous populations prompted him to promote a vegetarian diet, or at least a diet with minimal meat, grown in natural environments (Price, 1981).

These nutritional ruminations were developed further in the former Soviet Union, where posters showed muscular workers with the phrase “Eat More Meat” (Popkin *et al*, 1997). The Soviet government strongly



Oil on canvas by Dutch School. Private Collection. Photo © Peter Nahum at The Leicester Galleries, London/The Bridgeman Art Library



emphasized competition with the West, not only in space technology and science, but also in terms of diet and health. They essentially created a series of norms, standards and production targets to increase the outputs of the meat and dairy sectors of their economy. Russian nutritionists recommended a diet based on a ratio of 1 g of protein to 1 g of fat to 4 g of carbohydrate: they postulated that an average person should consume 120 grams of protein (55% from animal sources), 120 g of fat, and about 480 g of carbohydrate each day. Comments made by two general secretaries of the Communist Party and various heads of state illustrate this focus on animal proteins: “we plan the following increases in the consumption per capita: meat and meat products—2.5 times, milk and milk products—2 times [...] and some reduction in potato and bread consumption” (Kruschev, 1961). “The nature of the goals

that must be achieved in the next five-year period determines the increasing responsibility of agricultural committees, rural party branches, collective [...] farms. [...] The average annual production of meat in the next 5 years must exceed 14 million tons, the production of milk must exceed 92 million tons, the production of eggs—46 billion pieces” (Brezhnev, 1967).

**The ‘eat meat’ approach to agriculture and trade that had been central to the Soviet post-War economy can explain what happened, to a lesser extent, in the West**

Unfortunately, the insistence by Russian nutritionists that 55% of protein come from animal sources formed part of the

scientific and legal bulwark that led, ultimately, to crippling agricultural subsidies in the former Soviet Union—by the end, half of the Union’s debt was attributed to agricultural spending and the other half to military spending.

I got involved in the issue of the Soviet Recommended Daily Allowances (RDAs) as a member of the G7 team of economists, to help the former Soviet Union reform its economic system. A crucial feature was the high pensions and poverty levels that allowed 75% of Soviet citizens to receive transfer payments that were intended for the poor. These were based on the old Soviet RDAs that required high levels of animal protein (Brezhnev, 1967; Popkin *et al*, 1997). The governments of Michael Gorbachev and Boris Yeltsin made identifying and supporting the poor a priority, rather than those who could not afford the high meat and dairy requirements of the former Soviet RDAs. In order to create a revised food basket based on cheaper items that more people could afford, we had to revise these RDAs and lower the poverty line, to help the real poor (Zohoori *et al*, 1998; Lokshin & Popkin, 1999). This meant changing the RDAs and in turn facing off with politicians and labour unions who loved the high poverty line. The ‘eat meat’ approach to agriculture and trade that had been central to the Soviet post-War economy can explain what happened, to a lesser extent, in the West.

After the Second World War and the initial focus on reconstruction in Europe, western European governments and the USA began to invest heavily in the agricultural sector. In terms of value-added per farmer, productivity grew from 1% annually in the 1900–1940 period to 2.8% per year. Investments were made in mechanization (Gardner, 2002) and farmer productivity rose rapidly. Soybean and other oilseed crops also became important as cheap and efficient ways to produce edible vegetable oils and animal feed (Williams, 1984; Popkin & Drewnowski, 1997).

All of these changes were the result of enormous direct and indirect subsidies, but these were only a part of the total public investment. Marketing assistance, favourable tax policies, credit programmes and commodity programmes were all paid for by governments to enhance their agricultural sectors. Gardner (2002) has estimated that the total public investment in agriculture in 1940 was \$500 billion, compared with

\$2.5 trillion in 1990 (based on the value of the US dollar in 1992). Various scholars have tried to quantify research inputs and their effects on agricultural output and they have found strong financial returns linked with all research benefits (Alston *et al*, 2009). Still, the total effect of the direct and indirect programmes, investments, tax policies, subsidies and so on has not been fully established. Nevertheless, the Organization for Economic Cooperation and Development (OECD) estimates that 29% of the income of farmers in Western countries—more than \$283 billion in 2006, for example—comes from government subsidies, trade interventions or direct income transfers (Paarlberg, 2010).

**...although many educated, high-income Europeans and Americans have begun to shift to what is now felt to be a healthier diet, animal products remain central to a 'healthy' diet...**

A number of lower- and middle-income countries—led by Brazil, China and India—have tried to convince the USA and the EU to reduce agricultural subsidies and allow true competition in the global food market. The Doha Development Agenda (DDA), which commenced in November 2001 in Doha, Qatar, is the trade-negotiation round of the World Trade Organization. One of their initial key objectives was to lower agriculture trade barriers around the world, but as of 2008, talks have stalled. There is also considerable anger against and between the EU and the USA over their maintenance of agricultural subsidies—seen to be effectively barriers to trade. Farmers and their associations have also become effective lobbyists. Although their actions are not always as visible as the demonstrations of French farmers, they nonetheless curtail the ability of European and US politicians to reduce agricultural subsidies.

**T**his massive support of a farming system that has produced inexpensive animal food has not bankrupted the USA or Europe; nor has the emphasis on meat, dairy and animal protein consumption been followed as strictly and extensively as it was in the USSR. In the West, the goal has been to provide a healthy diet, defined as including adequate starchy staples such as bread and meaningful levels of animal-sourced foods: dairy, meat or poultry. In

other words, the USA and Europe did not set out to achieve a fixed level of animal food consumption, but they achieved this anyway.

In the 1960s, high-income, well-educated adults in the USA—especially white adults—consumed high-fat, high-meat diets, whereas lower-income adults consumed a healthier diet of mainly beans and vegetables (Popkin *et al*, 1996). Ancel Keys and others have shown how diets high in saturated fats contribute to heart disease (Keys, 1962), even though the received wisdom has been that such diets are good for you. More interestingly, although many educated, high-income Europeans and Americans have begun to shift to what is now felt to be a healthier diet, animal products remain central to a 'healthy' diet (Dansinger *et al*, 2005; Gardner *et al*, 2007; Sacks *et al*, 2009), as the focus on energy balance and weight seems to dominate.

The 1960s also saw the appreciation and greater consumption of specialty crops including vegetables, fruits and beans. Scientists also began to understand the role of fibre in the diet, especially from whole grains. Alston *et al* (2009) have so far provided the best examination of the relationship between fruits, vegetables and beans and research funding. They have shown that these crops are most likely to be underfunded, in relation to their economic benefit. Mark Hegsted, an eminent nutritionist, showed the harmful effects of saturated fats from eggs and meat on cholesterol and the positive effects of unsaturated fats from nuts (Hegsted *et al*, 1965). He was behind the 1977 Dietary Goals for the USA, which set maximum levels for meat, dairy and egg intake and were heavily criticized by the animal food sector (Carter, 1977). Hegsted tried to encourage more consumption of fruits, grains and vegetables, a suggestion that was met by a barrage of criticism from lobby groups. Hegsted was so far ahead of his time that few nutritionists defended him: the financial interests of the pork, beef, dairy and poultry sectors won, and his tough guidelines were never truly implemented (Carter, 1977).

**Our agricultural system is still based on the earlier goals of consuming animal products and sugar, fats and oils—which are accepted by key segments of society**

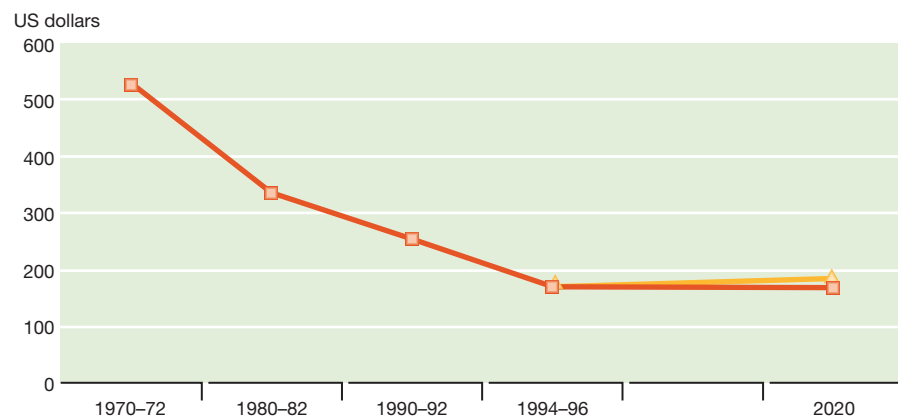
The situation today is different, as the nutrition profession—faced with high obesity and diabetes rates, and the prevalence of related cardio-metabolic conditions, which are linked to our high-sugar and high-saturated-fat diet—is seeking major changes (US Department of Agriculture, 2010). Health scholars have begun to show that lower-quality 'junk' foods containing high levels of saturated fat and sugar are cheaper than healthier foods (Drewnowski & Darmon, 2005; Maillot *et al*, 2007). In other words, the health benefits and economic costs are completely out of line. Nevertheless, public funding of agriculture between 1970 and 2004 did not change to reflect this new understanding of the health impact of specialty crops.

**Although many of us love to eat local food, this approach will not address global problems...**

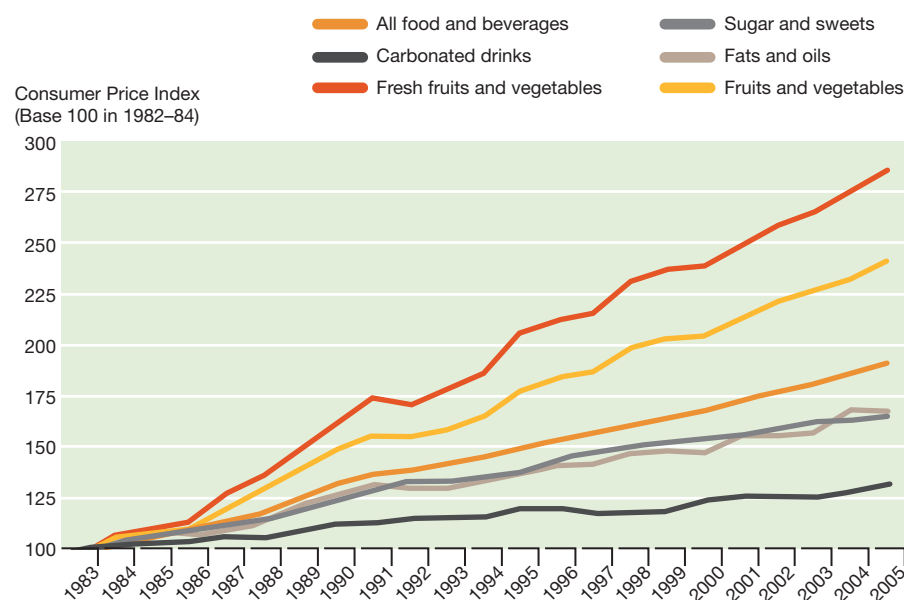
Our agricultural system is still based on the earlier goals of consuming animal products and sugar, fats and oils, which are accepted by key segments of society. This has led to a general conceptualization of how our agricultural system should evolve and what it should provide. Curiously, the father of modern nutrition and the initiator of the first food and nutrition division under the US agricultural research system, Wilbur Atwater, conducted his PhD dissertation on the composition of corn. He noted that, "our diet is one-sided and that we eat too much [...] fat, starch and sugar [...]. How much harm is done to our health by our one-sided diet [...] No one can say" (Muller *et al*, 2007). The main question is therefore whether and how a change in agricultural research funding and policies could encourage a healthier diet, with a reduced focus on animal-sourced foods.

**I** was recently at a meeting with organic farmers and others involved in local farmers' markets in the USA and Canada. When I asked whether we could form local markets in every state of the union, my fellow attendees used the small Iowan town of Pocahontas as an example in their answer. I was told that in Pocahontas, it would be next to impossible to create a farmers' market because the whole focus of agriculture there—irrigation, production, transportation and so on—is on corn and soybeans. It would be inordinately expensive for the farmers of Pocahontas to grow vegetables





**Fig 3** | Global prices for beef in 1990 US dollars. Source: International Food Price Research Institute, Washington, DC, USA.



**Fig 4** | Development of relative prices for various foods in the USA from 1983 to 2005.

and fruits on their land. The farmers I spoke to also told me that the driving issue has been to reduce the cost of corn and soybeans, which form the basis of caloric sweeteners, as well as 80% of all vegetable oil produced. They also pointed out that this cheap supply of cash crops was the main engine that has driven the beef and poultry industries.

Governments have invested a lot of money to research and develop these cash crops, making them as productive and inexpensive as possible. It is therefore not surprising that the world price for beef has declined from more than \$530 for 220 pounds (100kg) in 1970 to less than \$190 for the same amount in 1995 (Fig 3). This is a global market price

and not what we pay in the USA or the EU; it is a wholesale cost. Nevertheless, a similar decline has occurred for all of the commodities mentioned above—as a result of systematic assistance and guidance, administered in an array of ways.

Will prices go up for these foods if we cut agricultural subsidies? I suspect so, but there is conflicting evidence. Many of the subsidies end up in the profit margins of agribusinesses. Although we might not expect them to absorb reductions in their profits, there is also no requirement for governments to subsidize their shareholders in this way.

It seems that the broiler industry, for example, saved more than \$11.25 billion

between 1997 and 2005 because the price they paid for feed was 21% less than the cost of production (Starmer *et al*, 2006). Corn farmers made profits, but scholars have pointed out that the subsidies did not substantially increase the profits of the farmers, but rather benefited poultry agribusiness. These huge profits were also seen in the pork sector, where profits went to the big pork companies and not to the farmers (Starmer *et al*, 2006).

This is the result of a long history of varied policies—all focused on helping farmers to grow key crops and agribusinesses to produce animal products. However, because the government provides money that supports this behaviour, corn farmers, chicken farmers and, particularly, large agribusiness—dominated by names such as Archer Daniels Midland and Cargill—are unlikely to change their ways. It is therefore not surprising to discover that during the past 30–40 years the price of corn and soybeans has declined, while the price of fruits and vegetables—which are on the whole unsubsidized—have increased (Hunt *et al*, 2007; Fig 4).

We must realize that a huge disconnect exists between the prices farmers receive for a product and its retail cost. For instance, the prices that farmers receive for fruit and vegetables have declined in real terms during the past 40 years, but the prices that consumers pay have increased. In other words, farmers are not receiving the extra money—this goes to the middlemen, agribusinesses and major food chains. This has been shown nicely by one group of agricultural economists and it contradicts the naive thinking that agricultural policy—how much farmers are supported—is the sole cause of fruit and vegetable price dynamics. Due to the small proportion of food costs in the final costs of what we consume, we must question whether the agricultural system has anything at all to do with the cost of fruits and vegetables.

In fact, this disconnect means agricultural subsidies are only part of the story of the politics and economics of the agricultural sector. It also means that although the European, American and global agricultural systems have been designed to facilitate the cheap production of animal products, we do not fully understand how to reverse this situation and return to a healthier, more measured conceptualization of

agriculture, nutrition and diet. Tim Lang, in the UK, has also pointed out many other negative health and environmental effects of this system and some of the complexities involved in addressing it (Lang & Heasman, 2004; Lang *et al.*, 2009).

While it is tempting to say that buying at local farms and local markets and eating local produce will return us to an earlier era of consumption, this might be slightly naive. First and foremost, growing and eating locally is not efficient and has a large environmental footprint (Khan & Hanjra, 2009). Several studies have shown that the environmental cost of shipping small amounts over short distances is greater than that of shipping large amounts over long distances (Coley *et al.*, 2009). Second, eating locally will not lower the prices or enable low-income consumers to purchase healthier foods. Finally, it is precisely the economies of scale that result from massive-scale production in areas with sufficient water and appropriate soil and other conditions that has allowed us to conquer hunger. Although many of us love to eat local food, this approach will not address global problems; local, small-scale farms simply cannot support the world population.

**The idea that animal products should form the basis of a 'wealthy' or 'developed world' diet has been scientifically debunked, but remains the social aspiration of billions of people**

The produce sector will not be of much help either. The farming sectors that produce fruit, vegetables and beans are not well organized. This is related to the extensive funding provided to create the commodity organizations, such as the National Dairy Council, the National Cattlemen's Beef Association, etc. These organizations created advertising campaigns such as the 'Got Milk?' milk moustache series, 'Pork. The Other White Meat', 'The Incredible, Edible Egg' and 'Beef: It's What's for Dinner' in the USA and globally to promote these commodities. They also lobby in other ways to support their business.

Of course, agriculture is not the only problem; consumer demand is an equally important issue. We have created societies in the West that value and consume meat, dairy, poultry, fish and seafood. Over several

**Table 1** | Past and projected meat and milk consumption in developing and developed countries

	Developing countries				Developed countries			
	1980	1990	2002	2015	1980	1990	2002	2015
Annual per capita meat consumption (kg)	14	18	28	32	73	80	78	83
Annual per capita milk consumption (kg)	34	38	46	55	195	200	202	203

Source: FAO (2007) *Livestock's Long Shadow: Environmental Issues and Options*. Rome, Italy: Food and Agricultural Organization of the United Nations.

generations, a particular way of life has been promoted and this has shifted expectations about diet to include large amounts of animal-sourced foods. The developing world wants to eat the same way and is rapidly increasing its demand for meat and other animal products (Table 1; FAO, 2007).

Thus, we face a two-pronged issue, if we want to move away from consuming large quantities of animal products for many reasons, that might include reducing carbon emissions, conserving water supplies or improving health (Popkin, 2009; Sinha *et al.*, 2009). First, we need to shift relative prices to make it more expensive to consume animal products compared with fruit, vegetables and beans. Second, we need to increase demand for the latter, which is not simple to do, as indicated by the so far limited success of such efforts. Both of these issues are complicated by the hundreds of billions of dollars in annual subsidies for animal products—Paarlberg (2010) states a figure of US\$283 billion. Removing these subsidies, although necessary, might not be sufficient to tip the balance.

Refocusing our agricultural system on healthy foods will also not address the issue of the high levels of sugar and fat in our diet. At the most basic level, we need to teach people how to cook. In fact, the UK has built teaching kitchens in its middle schools in the past few years in order to enable children to take the required cooking classes (King, 2007; Popkin, 2010). Moreover, a disproportionate number of processed foods and beverages contain added sugars and many others contain excessive fats and are often fried in oils. The top target should be beverages; when we consume a caloric beverage we do not compensate for this by reducing our food intake, as we would if we had consumed a caloric food. This is an issue worthy of its own perspective (Popkin *et al.*, 2006; Popkin, 2008; Duffey *et al.*, 2010; Malik *et al.*, 2010).

The road ahead is long and hard and will require a change in perspective on a global scale. It will require action from the World Bank, the UN Food and Agriculture Organization and many other multinational institutions, as well as from national ones across the globe. The idea that animal products should form the basis of a 'wealthy' or 'developed world' diet has been scientifically debunked, but remains the social aspiration of billions of people. As the West slowly comes to accept that its diets and eating habits are not healthy, it is to be hoped that there can be a concomitant adjustment in agricultural subsidies, research and policies to provide both a healthier diet and more and fairer opportunities for consumers and farmers throughout the world.

#### CONFLICT OF INTEREST

The author declares that they have no conflict of interest.

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