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## Preventing type 2 diabetes: Changing the food industry

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### Abstract

Improving our global diet by working with the food industry is a fairly complex task. Previously the global food manufacturing companies and governments were the major players. However, matters have shifted rapidly so that food retailers, food manufacturers, the restaurant–food service sector, and agribusinesses are now the major players. The current modern system of packaged processed food has now penetrated the globe—rich and poor, rural and urban are all in reach of this food system. Consequently, working with this complex sector when possible and an array of governmental regulatory large-scale options to improve our diet have increased in importance. Taxation of unhealthy foods and beverages, marketing controls, and front of the package labeling are the primary current options. Evaluations of the impacts of both public and industry initiatives are needed.

### Keywords

food industry; retailers; food service sector; agribusiness; taxation; marketing controls; front of the package labeling

### A. Introduction

Our diet directly affects our risk of diabetes, and it also impacts on obesity. We focus here on the global diet in the larger context, and what it will take to create a food system that promotes healthy diets. This chapter takes a broad view to provide a global sense of the growth of the retail food and food service sectors and the dynamics of agricultural policies. The overall system and its major players, who are driving what farmers produce and the entire farm-to-fork organization, have changed dramatically in the past four decades. We describe these changes as a basis for fresh thinking about how we direct food policy to improve global eating patterns.

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#### Conflict of Interest

Barry Popkin has no conflict of interest.

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## B. Underlying global dynamics

### Growth of the retail and food service sectors from high-income to low- and middle-income countries

Global agriculture and food production and processing have transformed remarkably. The urban and rural poor across the world selectively purchase increasing amounts of processed foods from modern retailers. At the same time, ongoing studies by Tom Reardon and others document the enormous growth of the modern agricultural retail sector in low and middle-income countries [1, 2].

In the United States and many other high-income countries about 70% of the food consumed comes from the retail sector and the remainder from away-from-home eating [3]. Of the food from the retail sector, about two-thirds is highly processed, and only a small proportion is marketed as random weight fruits, vegetables, grains, or animal source foods [4]. The amount of processed food purchased varies globally.

In low and middle-income countries (LMIC), agricultural economists have shown that fresh produce and meat remain available mainly in traditional food retail sectors, while packaged food is predominantly purchased in modern retail chains [1]. Our research using direct measurement of dietary intake suggests remarkable transformations in Mexico (and potentially other rapidly growing Latin America countries) and also that future ones will be documented in the consumption of processed foods in Asia. In two recent national surveys in China and Mexico we asked in 24-hour dietary recalls the origin of each food individuals consumed, whether it was processed and packaged or not [5, 6].

Overall in Mexico 58% of all calories consumed came from packaged foods and beverages. Elsewhere we have shown that the percentage is rapidly growing in the beverage sector, but we have not explored trends in food [7]. China is at an earlier stage of retail sector growth, yet its retail sector grew from US\$13.1 billion in sales from 47 food chains in 2001 to \$91.5 billion in 2009, with the rate of growth increasing in all Asian countries [8]. In 2011, 30% of the Chinese daily energy intake came from the packaged food and beverage sectors. Indeed we see that more than a third of the calories come from this sector in the three Chinese megacities (Beijing, Shanghai, and Chongqing) with 8 to 24 million people.

It is useful to understand what types of processed packaged foods and beverages the residents of one of these countries consumed. Overall, in Mexico the major processed and packaged caloric contributors are from dairy items, tortillas, sugar-sweetened breads and desserts, salty snacks, meats, mixed dishes, and sugar-sweetened beverages (SSBs). These groups represent about half of all processed packaged food calories. Tortillas might seem like an unlikely processed food; however, in Mexico about 98% of the masa flour used in tortillas is mill and comes from two major manufacturers [9]. By fiber to total carbohydrate ratio, one definition of whole grains, it appears that most of this commercially prepared corn flour is still whole grain.

The retail sector has penetrated all cities and most villages in almost all LMICs, which raises an issue that many in the food policy field attempt to ignore, namely, that increasingly the

bulk of calories across the globe comes from packaged processed foods and beverages. Furthermore, recommendations that people eat real food are a potentially healthy option, but it is becoming unrealistic for the bulk of the globe [10–13].

The global food service sector is the second major growth component. Away-from-home eating is enormously varied across the globe. At one point supermarkets and retail food outlets were not part of this sector, but now ready-to-eat hot food or ready-to-heat prepared dishes are available in various sources, from retail food stores to food trucks, sit-down stalls, and fast food and other restaurants. Euromonitor and other groups measure only the major chains. To understand fully the complexity of the food service sector requires detailed data on food purchasing behavior that is acquired directly from consumers [14].

### C. The history of agricultural policy and the global food system

The shift to a global food system started in the United States and other high-income industrialized countries, driven initially by government investment in infrastructure and research and policies intended to raise farm production. While this modern food system developed in the United States and Europe mainly after World War II (WWII), we should not dismiss the importance of earlier developments [15]. These include the creation of the US Department of Agriculture in 1862, the authorization of US public land grants for colleges to teach agriculture, the development of an array of agricultural cultivation techniques, technologies and tools. This includes the discovery of nitrogen fertilizers, breeding techniques, and more modern genetic splicing. Artificial insemination; controlled feeding; crossbreeding; and disease control improvements for livestock, poultry, and the dairy industry also developed in the 40 years prior to WWII [16].

Much of the US funding focused on a few major crops, particularly grains (e.g., wheat, corn, rice), oilseeds (e.g., soybeans), cash crops (especially sugar), and livestock (e.g., pigs, poultry, and cattle). Sugar was one of the first crops to benefit from government money. For instance, the Sugar Station, founded in 1885, is the oldest of the Louisiana Agricultural Experiment Stations. Outside the United States, funded research systematically increased 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 [17].

The US agricultural sector undoubtedly played a crucial role in the development of the US economy and society. Railways to transport livestock, among other things, opened the US Midwest, and canals were built to move grains. However, despite these enormous advances between 1870 and 1945 there was actually little yield increase in key crops, such as corn, wheat, potato, and cotton [18]. There were also radical changes in agricultural policy, as the Great Depression ushered in subsidized commodity programs, whose progeny still dominate US agricultural policy [16].

After WWII and the initial focus on reconstruction in Europe, Western European governments and the United States began to invest massively in the agricultural sector. In terms of value-added goods per farmer, productivity grew from 1% annually in the 1900–

1940 period to 2.8% per year with higher growth in the US than Western Europe. Major investments in mechanization occurred [16], and farmer productivity rose rapidly. Soybean and other oilseed crops became important as cheap and efficient ways to produce edible vegetable oils and animal feed with new technologies developed in the 1950's [19, 20].

All of the changes were the result of enormous direct and indirect subsidies, but these were only a part of the total public investment. Governments paid for marketing assistance, favorable tax policies, credit programs, and commodity programs to enhance their agricultural sectors. Gardner (2002) has estimated that the total public investment in agriculture in 1940 was US\$500 billion, compared with US\$2.5 trillion in 1990 (based on the value of 1992 dollars) [16]. Various scholars have also tried to quantify research input and its effects on agricultural output, documenting strong financial returns linked with all research benefits [21]. The Organization for Economic Co-operation and Development estimated 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 [22].

In the West the goal has been to provide a healthy diet, defined to include adequate starchy staples, such as bread, and meaningful levels of animal source foods, including dairy, meat, and poultry. In other words, although the United States and Europe did not set out to achieve a fixed level of animal source food consumption, they achieved it anyway.

At the same time, nutritionists and other experts began to take a closer look at diets with the aim to improve health. In the 1800s Atwater (1844–1907), Voit (1831–1908), and other scholars called for improvements to the diets of laborers, soldiers, and workers in Western Europe and the United States to include 100 to 200 grams of protein per 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. They also encouraged the consumption of animal products as a focus on protein quality, while few scholars promoted a vegetarian diet, or at least a diet with minimal meat, always grown in natural environments [23].

Today the global agricultural system is still based on the earlier goals of consuming animal products and sugars, fats, and oils—goals 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, Atwater, the father of modern nutrition and the initiator of the first food and nutrition division under the US agricultural research system, 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*” [24].

A parallel development in other high-income industrialized countries was the post-WWII establishment of the Common Agricultural Policy in what is now the European Union. Industrialized countries also took steps to protect their agricultural markets from imports from other countries. State intervention in most LMICs took a different form, including

policies to subsidize food, income and land taxes on agricultural producers, and systems to control the supply and marketing of key commodities [25].

Not only did these agricultural changes accelerate exponentially in higher income countries [16], but also there were significant agricultural transformations started in LMICs with the “green revolution” in the 1960s. These investments and changes in production systems were designed to make calories from staples (e.g., wheat, corn, rice, and soybeans) cheaply available, to simultaneously conquer widespread under nutrition in LMICs and respond to concerns about food insecurity in high-income industrialized countries [26].

This model spread unevenly to most LMICs [8, 27, 2]. Many countries retain partial forms of state intervention in agriculture and food systems aided by the market-oriented “structural adjustment” that began in the late 1970s and the introduction of agriculture and food into global trade agreements in the early 1990s [28–30, 9].

The major drivers of this global food system have changed remarkably in the past few decades (Figure 1). The most insightful and provocative study is that of Reardon and a team of scholars that examines the entire food chain in India, Bangladesh, and China and looks at how the food value chain is transforming in the context of this dynamic modern food system [31]. This poses major challenges as our food system is driven increasingly by retailers and large packaged food and beverage companies. Furthermore, there are two elements to consider in their work. If indeed the food value chains are transforming and modern retailing is growing rapidly, the food consumed and available to both the urban and the rural poor will be entirely different in the next few decades. Agriculture policy and food policy in general need to face this new reality in a thoughtful manner. We know already that in the United States and many other high-income countries and some LMICs that the retail sector plus agribusinesses have already created full vertical integration of the food value chain from farm to factory or retailer. This is happening rapidly in LMIC’s [31].

An example of the power of the new drivers of the food system is the fact that globally Nestlé directly contracts with 750,000 farms [32]. As described by the CEO of Nestlé, the company trains and works directly with the farmers on all stages of food production, harvesting, and transport. Magnify this by not only the major packaged food and beverage companies but also the major retailers, food service companies (e.g., McDonald’s), and agribusinesses like Bunge and Cargill and you can see the power of these players [8].

#### **D. Global options to change our diets via the new drivers**

In the past one might have considered working directly with governments and farmers to change crops, reduce or increase subsidies, and subsequently affect the relative cost of various foods and hence our diets directly. This is essentially what occurred in the post-WWII period and the green revolution. At the same time, income transfer programs, food fortification, or direct food subsidy programs reached many subpopulations with minimal incomes or those outside the cash food system. This is how North America and Europe addressed hunger in the post-WWII period and how many of the higher-income countries among the LMICs, such as Mexico and China, have addressed malnutrition. However, the

obesity and diabetes epidemic in both urban and rural areas of various countries necessitates much different thinking concerning the changing food system [33].

Clearly, agricultural research and innovation remain critical and can improve diet quality. Innovation can enhance the nutrient compositions of major grains (e.g., increasing the carotene content of golden rice) and improve agricultural productivity as we face changing climate conditions, water scarcity [33], and many other factors [34, 35]. Yet our concern is the overall healthfulness of the diet, and the experience of the past half century makes it appear impossible to truly change the basic goals of our agriculture system.

This leads to a much greater emphasis on regulatory options and the initiatives of the retail and food service sectors. Many countries and even cities (e.g., New York City's sodium reduction initiative) rely on three major large-scale options. Below we also discuss voluntary options.

### **Incentivize consumers: Relative price shifts**

One of the major pushes in many countries across the globe has been taxation of less healthful foods and beverages. A clear focus has been on SSBs. This relates to reducing the risk of diabetes and obesity and other adverse cardiometabolic outcomes [36]. The underlying biology shows that what we drink, be it water or a caloric beverage, does not appear to affect the amount of food we consume [37, 38].

Taxation of SSBs is a key goal of most people working in public health, yet it has limits. As many studies have shown, ultimately 100% fruit juice must also be taxed. The net effect, if the tax is high enough, will be a significant reduction in unhealthy beverage consumption. We have three examples of smaller taxes in the range of 8% to 10% in France, Chile, and Mexico, and a higher tax in the city of Berkeley ( $\approx$  9–14%). Only Mexico has conducted a rigorous evaluation of the impact of its tax on purchases of SSBs. There, in response to the SSB tax, all powdered drinks have shifted from caloric sweeteners to low-calorie sweeteners to prevent taxation of the product. Below we describe those and other results.

A second tax is that on what we might call nonessential food or junk food. Mexico's 8% tax, again quite small compared to what we would recommend, is an example, as is the Hungarian junk food tax and the short-lived Danish saturated fat tax.

The popular press sees the option of working with governments to remove subsidies of products such as corn as effective. However, scholars view that option as only affecting the profits of the big four players in the food systems, at least in the United States, and not as seriously affecting the costs of high-fructose corn, corn syrup, or corn-fed cows [39, 40].

### **Marketing controls**

While it is clear that in controlling tobacco complete removal of all cigarette marketing reduced the prevalence of smoking in many countries, much of the dialogue about marketing of unhealthy foods has focused on children [41–46]. Given the billions of dollars spent globally to market unhealthy foods and beverages, it is impossible to consider how we can change the culture of eating without eliminating or controlling this marketing [43]. Global



and national authorities have repeatedly called for such controls, yet only recently have a few countries begun to take this topic seriously. Chile, Ecuador, Peru, France, a few other European countries, and South Korea are among those instituting meaningful controls. However, to date most have focused on either limited TV hours, especially children's programs, and have ignored both the fact that children watch a variety of other programs and the array of media outlets the food and beverage industry uses. We will discuss one of Chile's newer, more comprehensive marketing control laws below.

### **Front of the package labeling: Options and current knowledge**

The last two decades have seen an increasing focus on simpler ways to identify healthy or unhealthy foods and beverages in both retail food outlets and the food service sector. In the retail sector we have seen either simple, positive logos, exemplified by the Scandinavian tick and the Choices International Foundation efforts [47]; a clear negative warning logo, personified by Chile's and several other countries' warnings about excessive sodium, sugar, or saturated fat [48]; complex traffic lights with multiple components on a label [49, 50]; or the food industry's Guideline Daily Amounts (GDA's) [51]. The latter was developed by the food industry in the United Kingdom. Many in the nutrition field feel that GDAs confuse consumers, use outdated sugar and other reference standards, and are developed to hold off labeling food as either good or bad.

To date the only research on these varying front of the package (FOP) labeling systems has been the Choices Programme work to identify the reformulation companies undertake for their products to be labeled healthy and consumer knowledge and attitude studies. No research on how these systems affect food purchasing patterns, overall dietary intake, and health has been published. The most important gap is in purchasing behavior. The crude, almost anecdotal studies on the Guiding Stars system [52, 53], one of the several systems retailers have developed, are not transparent in their published cutoffs and tend to focus on overall diets rather than food groups. Other much larger retailers, ranging from Walmart [54] to Ahold [55] to Kroger (NuVal), have created their own labeling systems to identify healthier products [56]. Labels that are transparent and oriented toward food groups tend to promote reformulation in the same way the SSB tax in Mexico has encouraged a shift from caloric sweeteners to low-calorie sweeteners. Reformulation to reduce sodium, added sugar, or unhealthy fats are all seen as positive, and reformulation that increases whole grains, fruits, vegetables, legumes, and many other foods is seen as healthier. Another set of changes can be made either independently by the food industry or in public-private partnerships.

### **Stealth and overt reformulation: What conditions have driven industry?**

To create healthier products by reducing sodium, added sugar, or unhealthy fats, the food industry has adopted stealth reformulation [57–59]. In private, off-the-record meetings with leaders of global food companies I have seen evidence of unpublicized reductions of sodium and added sugars in an array of products. Often, for example, manufacturers have noted that if they mentioned publicly that a product contained reduced sodium or sugar they would lose sales. I feel that while this approach may work for some food companies, a level playing

field and true change will require systematic regulations, FOP or other types of labeling, and marketing controls. Taxation of added sugar or sodium could also be highly successful.

### **Public-private partnerships**

Public-private partnerships abound across the globe, and many people see them as a way to relieve pressure on the food companies without creating serious change [60]. The United Kingdom's Public Health Responsibility Deal Food Network is the widest-ranging national effort aimed at cooperation between the food industry and the government [61, 62]. Unlike the United Kingdom's earlier activities prompted by the excellent Foresight Obesity report [63, 64], this new approach is wrought with the complexities of obtaining voluntary commitments with no option to legally ensure that they are met. The food industry commonly uses the tactic to forestall regulations, often quite successfully [65, 66]. However, few evaluations of these commitments have ever found that the industry meets them [67, 68].

The Healthy Weight Commitment Foundation (HWCF) brought together in the United States 16 global food companies that committed to reduce their US caloric sales by 1.5 trillion kilocalories (kcal) per year, to improve the quality of global diets [69, 70], and to an independent evaluation funded by the Robert Wood Johnson Foundation, which selected my team to lead that evaluation. This effort is linked with the Partnership for a Healthier America initiative led by Michelle Obama [71]. The HWCF is the only aspect of the partnership that set rigorous public and transparent goals and is open to serious outside independent evaluation.

## **E. What works**

We have some critical global goals, including reducing intake of added sugars, particularly in beverages, reducing refined carbohydrate intake, and increasing intake of whole grains and foods such as nuts, legumes, fruits, and vegetables. Elsewhere an excellent consensus statement and review goes in-depth into heart-healthy dietary changes we need [33]. We also realize that the Michael Pollan recipe to eat food, mainly plant food, in limited portion sizes will not work for the large proportion of households, which increasingly rely on packaged processed food.

### **Industry reformulation efforts and shifts in purchasing patterns**

One major food industry effort suggests some potential incentives to reduce the calories sold, but indications of a major push toward a less obesogenic and more diabetes preventive diet are minimal. The stealth reformulation work remains anecdotal. Only one rigorous evaluation exists.

We evaluated the 16 HWCF companies that committed to work to reduce the calories Americans consume. These companies sold 6.4 trillion fewer calories in the United States in 2012 than in 2007 [72]. The companies collectively pledged to remove 1 trillion calories from the marketplace by 2012 and 1.5 trillion by 2015. More detailed analysis of food purchase patterns by type of household, by HWCF brands, by non-HWCF brands, and by private label (PL) (retailer branded products) brands is required. For the study on families with children, researchers tracked national purchases of snacks, cereals, breads, drinks, and



other packaged goods from 2000 to 2007 (before the HWCF pledge) and from 2008 to 2012 (during the HWCF pledge). Some researchers found that families were already starting to buy fewer calories in the form of packaged goods before the HWCF companies' calorie-reduction pledge began and, based on those trends, expected a bigger drop in the number of calories families bought as HWCF brands during the actual pledge period [73]. Others cast doubt on whether the results of the shift to PL from HWCF brands and the reduction were planned before the pledge [74], but this cannot be known. Nevertheless, it is clear that US households with children either have responded to industry changes or have led the changes based on concern about child obesity and awareness of the issues [3]. It is also clear, although the reasons are not adequately documented, that industry shifts toward replacing caloric sweeteners with low-calorie ones are increasing in the United States [75].

However, despite these changes, which may be linked with a slowdown or a plateau in obesity across all child age groups, the American diet quality has not improved significantly. The only clear change is a reduction in SSB intake. This is positive, yet still over 60% of Americans aged two and older consume over 200 kcals per day of added sugars [76]. Furthermore, no studies of retailers have shown major purchasing pattern shifts toward a healthier diet.

### **Taxation**

The Mexican SSB tax and the Danish saturated fat tax are the only taxes with rigorous evaluations. The latter was so short-lived that, while it saw a large shift in purchasing patterns, it is hard to know what the long-term impact would have been. The Mexican SSB tax was only a 10% tax, contrary to recommendations of at least a 20% tax. Nevertheless, the results were significant [77], the tax working exactly as earlier studies in Mexico predicted. The tax, which went into effect January 1, 2014, applies to nondairy and nonalcoholic beverages with added sugar. Preliminary results show a 6% average decline in purchases of taxed beverages in 2014 compared to pretax trends. The reduction accelerated and reached 12% by December 2014. All socioeconomic groups reduced purchases of taxed beverages. Reductions were higher among lower socioeconomic households, averaging a 9% decline in 2014 compared to pretax trends and up to a 17% decline by December 2014. Results also show a roughly 4% increase in purchases of untaxed beverages during 2014, mainly driven by an increase in bottled plain water (tap water intake is not collected).

### **FOP labeling evaluations**

To date no evaluations of the impact of FOP labeling programs on food purchasing patterns have been rigorous, well designed, and controlled. Only the international Choices Programme has monitored reformulation [47, 78] and showed that products have been reformulated to gain the logo of reduced sodium, added sugar, and saturated fat and increased fiber.

### **Joint marketing controls and FOP labeling**

Chile was one of the first countries to link FOP logos with marketing controls. Chile will phase in requirements over a 3-year period from July 1, 2016, to July 1, 2019, on what can be marketed and what will receive an adverse logo. Table 1 provides the criteria for the FOP

logo and marketing controls that will be initiated in 2016–2018 following the law's recent implementation. Plans are to initiate an evaluation using a rigorous design, Nielsen food purchase data, and media monitoring data.

### New initiatives

It appears that a number of Asian countries, including China, Thailand, Malaysia, and Singapore, will institute the Choices Programme or a version of it over the next year. Again, we would expect resulting product reformulation but are unsure about the impact on purchase patterns.

## F. Summary

Our global food system is growing in complexity, and the role of the food industry varies by location. One needs to think of retailers, food services, global agribusinesses that mainly handle commodities, and food manufacturers as four separate players. Each deserves attention and must lead or be led via regulations and taxation to create a better diet for the planet.

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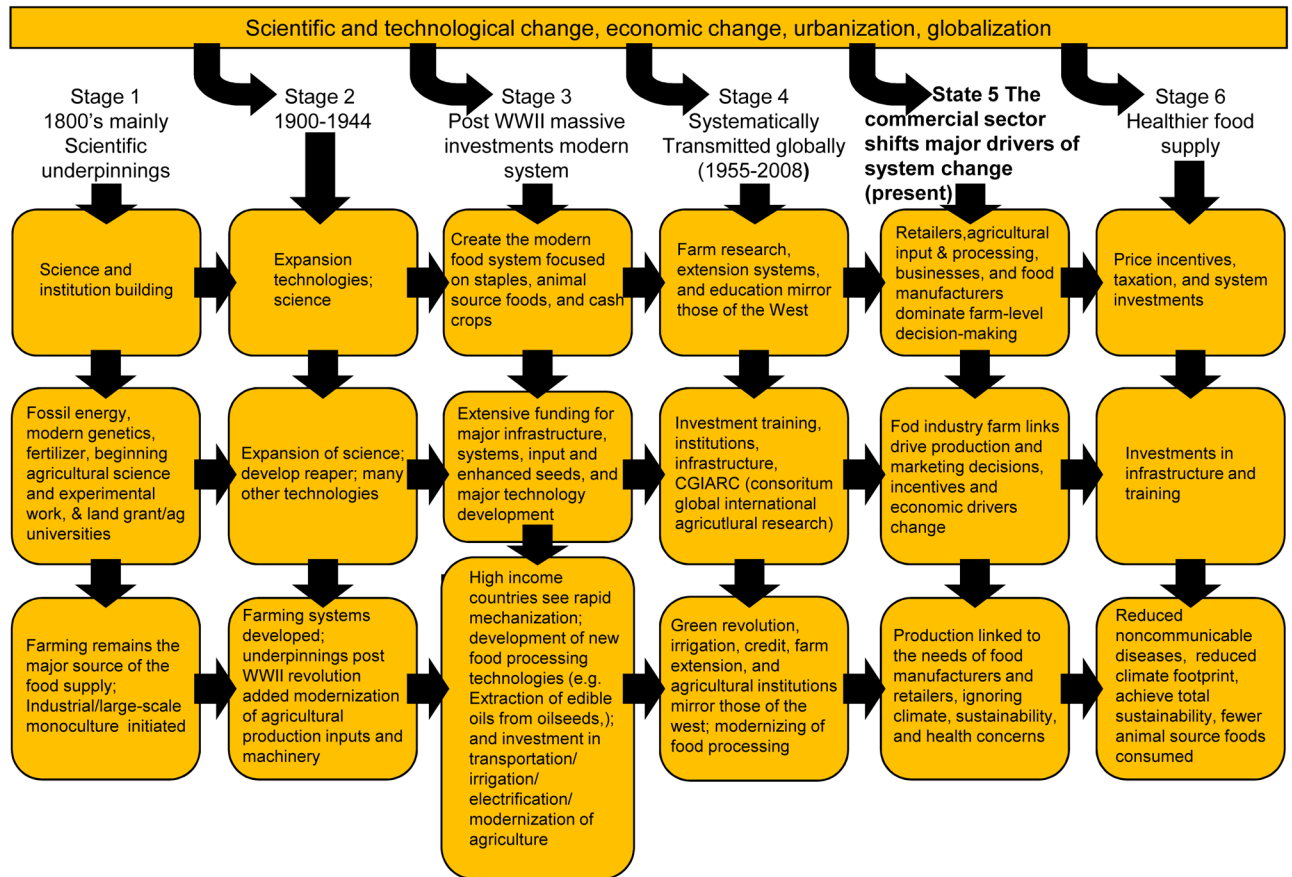


**Practice points**

- 1** Support public policy to tax sugar-sweetened beverages and other taxes which make unhealthy sugar-rich refined carbohydrate foods relatively more costly
- 2** Support subsidies for whole grains and healthier beverages such as potable water.
- 3** Support food industry reformulations which reduce added sugar in foods and beverages and increase whole grain content of grain-based foods.
- 4** Support ways to limit marketing of foods and beverages linked with increased risk of diabetes.

### Research Agenda

- 5 We need rigorous peer-reviewed unbiased evaluations of regulatory and pricing initiatives that attempt to improve diets.
- 6 We need to develop experimental designs to test out various new large population approaches to improving diets of the most vulnerable populations in our country.
- 7 Research on retailers and how we can work with them to improve access and purchases of healthier foods and beverages is needed.
- 8



**Figure 1.**  
Stages of Global Agricultural System's Development

**Table 1**

Chile's nutrient limits and implementation dates

	12 months after official publication	24 months after official publication	36 months after official publication
A. Solid foods			
Energy, kcal/100 g	350.0	300.0	275.0
Sodium, mg/100 g	800.0	500.0	400.0
Total sugar, g/100 g	22.5	15.0	10.0
Saturated fat, g/100 g	6.0	5.0	4.0
B. Liquids			
Energy, kcal/100 g	100.0	80.0	70.0
Sodium, mg/100 g	100.0	100.0	100.0
Total sugar, g/100 g	6.0	5.0	5.0
Saturated fat, g/100 g	3.0	3.0	3.0

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