6 The contribution of the processed food sector to the triple challenge

This chapter provides an overview of the processed food sector as it relates to each dimension of the triple challenge. The term “processed food” is defined here as any food that has been altered in some way from its raw state. The processed food sector accounts for a significant share of income generation and employment and is essential to maintaining a steady global supply of safe, affordable, and nutritious foods and is thus key to supporting food security and nutrition. Despite broad benefits brought by food technology, some processing activities produce foods that are energy-dense and nutrient-poor and are associated with negative health effects when consumed in excess.

Key messages

- Processing (any alteration of food from its raw state) is a significant sector of the global economy, contributing to food security and nutrition as well as livelihoods.
- Processed food enables the supply of safe, affordable and nutritious foods.
- Excess consumption of processed foods high in salt, fat and sugar contributes to negative health impacts.
- Consultation with industry and public/private partnerships are crucial so that policies are practicable and regulations do not impede industry innovation; transparency and equal access are important to avoid policy capture.

6.1. Introduction

This chapter investigates how the processed food sector contributes to the triple challenges facing food systems: ensuring global food security and nutrition, providing livelihoods to farmers and others along the food chain, and using natural resources in a sustainable manner.

The consumption of foods that have been processed to varying degrees constitutes the final stage of the agro-food supply chain.[1] Processed foods, and the processed food sector more broadly, make important contributions to the economy and to dietary patterns worldwide. Indeed, food and beverage manufacturing ranks among the top three manufacturing activities in terms of value added in 27 OECD countries.[2] In 2019, the world's top ten food, beverage and tobacco[3] companies generated over USD 539 billion in revenues.[4]

Several types of food processing have a positive impact on the safety and quality of food products and are essential to supporting safe, affordable, and nutritious diets. Nevertheless, there is growing concern about the regular or excessive consumption of energy-dense and nutrient-poor processed food products to overall dietary quality and human health. According to the Global Burden of Disease Study (Afshin et al., 2019[1]), in 2017 poor diets were responsible for 11 million deaths worldwide, surpassing the number of deaths attributable to smoking. Conditions of over-nourishment (i.e. consuming too many calories) are rapidly increasing worldwide, with some 39% of adults categorised as either overweight or obese in 2016 (FAO, 2019[2]). Excessive consumption of sugars, salt, oils, and fats is associated with higher prevalence of overweight, obesity, specific forms of cancer, and other non-communicable diseases (NCD), contributing to the overall level of malnourishment and the global disease burden. In addition, several farm-level practices and manufacturing techniques involved in the production of processed foods contribute to environmental degradation. To overcome these problems, public policy can help support and complement the efforts of the processed food sector to improve food safety and quality, as well as the sustainability of food systems.

The processed food sector is at the interface of supply and demand, and has the potential to influence both on-farm practices and consumption patterns. Interventions that target the processed food sector offer opportunities to take advantage of important synergies across policy areas. For example, policies that incentivise the alignment of processed food composition or variety with dietary guidelines, while also stimulating sustainable production practices, have the potential to improve both public health and environmental outcomes. Policies that promote various labelling schemes for packaged products could similarly support the consumption of food products with improved nutritional, social, or environmental characteristics while potentially offering new value creation opportunities for actors along the agro-food value chain. This chapter looks first at how the processed food sector relates to each component of the triple challenge, and highlights the synergies and trade-offs across these policy areas. It then provides a policy perspective, examining both some of the issues that need to be navigated to develop more coherent policies, as well as existing or proposed policy mechanisms that target the processed food sector. The policy examples and insights from OECD country experiences presented build on the four-track approach developed in previous OECD work (Giner and Brooks, 2019[3]).[5]

6.2. Food security and nutrition

What is processed food?

Processed food, as used in this chapter, refers broadly to any food that has been in some way altered from its raw state. As such, this term covers a wide diversity of food products. Food processing encompasses a wide range of activities, and most foods are processed to some degree before consumed. For example, foods may undergo low amounts of processing via activities such as peeling, chopping, freezing, drying, or a number of other preparation or preservation techniques before they are purchased. Similarly, consumers may process food at home before they are consumed (e.g. by peeling, chopping, or boiling). Other food products are the result of multiple, sophisticated industrial procedures.

The term "processed food" is thus vague and unhelpful when used broadly, as it ignores the wide variation in processed food products. For this reason, several frameworks have been proposed to disaggregate the category of processed foods (Monteiro et al., 2019[4]). The NOVA classification is used most commonly in the scientific literature, and for this reason, it is described briefly here.[6] This system groups food into four categories based on the extent and purpose of industrial processing, from unprocessed and minimally processed foods (e.g. frozen or dried fruits and vegetables) to ultra-processed foods (Monteiro et al., 2017[5]; Monteiro et al., 2019[6]). Ultra-processed foods are defined as "formulations of ingredients, mostly of exclusive industrial use, that result from a series of industrial processes" (Monteiro et al., 2019[4]). Examples of food products included in this category are carbonated soft beverages and other sugar-sweetened beverages, sweet or savoury packaged snacks, confectionery, industrial packaged breads, buns, cookies, pastries, cake and cake mixes, breakfast cereals, cereal and energy bars, margarines and spreads, processed cheese, energy beverages, sugared fruit yoghurts, meat and chicken extracts, and instant sauces, infant formulas, follow-on milks and other baby products, 'health' and 'slimming' products such as powdered or 'fortified' meal and dish substitutes, and many ready-to-heat products including pre-prepared pies and pasta and pizza dishes, poultry and fish 'nuggets' and 'sticks', sausages, burgers, hot dogs and other reconstituted meat products, and powdered and packaged 'instant' soups, noodles and desserts. Food products falling under this category are often engineered to be highly palatable, affordable, and convenient (e.g. they are often sold ready-to-consume) (Monteiro et al., 2019[4]).

A classification system can be a helpful tool that allows for greater specificity when discussing the wide range of available processed food products and the processing techniques employed to make these products. However, this report recognises that the NOVA classification is not universally defined or employed, and further, that there is no universally agreed upon categorization system for the diverse array of products that come from the processed food sector. A detailed discussion of the merits and criticisms of the NOVA classification, and in particular the use of the term 'ultra-processed', is not a focus of this report (though a very brief overview of some of the common criticisms is provided in Box 6.1). This report only uses terms from the NOVA classification, such as "ultra-processed", for the sake of clarity when discussing the results of scientific literature that uses the NOVA classification.

Food that is processed does not by itself define the singular relationship of each food product to consumer health. While this section brings together conclusions drawn from several articles using the NOVA classification, as well as articles using other classification schemes, the discussion on nutrition and health focuses mostly on processed foods that are energy-dense and nutrient-poor – in particular products that are high in sodium, free sugars, and/or some fats – in order to distinguish them from the larger assortment of all other processed food products. It should be noted here that the use of food technology is not inherently problematic, and that indeed many food technologies bring important benefits that support food security and nutrition.

Box 6.1. Common criticisms of the NOVA classification

The NOVA classification groups foods into four categories according to the extent and purpose of industrial processing: (1) unprocessed or minimally processed foods; (2) processed culinary ingredients; (3) processed foods; and (4) ultra-processed foods.

The NOVA classification has been widely applied in the scientific literature examining the links between dietary patterns and health outcomes, and has been presented in publications by the United Nations Food and Agriculture Organisation (Monteiro et al., 2019[6]) and the Pan American Health Organisation (PAHO, 2015[7]). There is growing evidence across countries of an association between the excessive consumption of ultra-processed foods and a higher risk of developing conditions of overweight, obesity, and various NCDs. At the same time, there is considerable criticism of the NOVA classification, including:

- The NOVA classification is not universally used or defined, and the definition of "ultra-processed" foods has evolved since its initial introduction, resulting in situations where this classification is understood and applied inconsistently across studies and over time.
- The NOVA classification does not consistently generate groups of foods with similar nutrient profiles. Due to the focus on the degree of processing, foods with substantially different nutrient contents may be grouped together, while foods with similar nutrient contents fall into different NOVA categories. For example, fortified foods with high micronutrient contents can be grouped with other energy-dense and nutrient-poor foods, such as various confectionery.
- There is a lack of sufficient evidence to characterise ultra-processed foods as hyper-palatable with the effect of promoting over-consumption (Gibney et al., 2017[8]).

Traditional data sources on food intake (such as 24-hour dietary recalls and food frequency questionnaires) are typically not designed to collect detailed information on food processing activities. A lack of specific data on food processing could lead to misclassification of foods within NOVA (Poti, Braga and Qin, 2017[9]).

The processed food sector is essential to the provision of safe, nutritious, and affordable food across the globe

Food processing techniques play a key role in food safety, storage, transport stability, and trade (Knorr and Watzke, 2019[10]). Techniques such as drying, smoking, canning, freezing, pasteurization, and fermentation are used to preserve foods, and, as such, can increase the availability and stability (important dimensions of food security, in addition to access and utilisation) of the food supply across seasons and geographic regions, for example by enabling the trade of products that would otherwise perish or deteriorate in quality. This is the case, for instance, with exports of milk powder from New Zealand, a leading exporter of dairy products (OECD, 2016[11]), which depends upon dehydration processing techniques to remove water from liquid milk. Preservation and storage techniques are particularly important to increase resilience in rural or remote areas of developing and least developed countries that may experience intermittent shortages and/or drastic seasonal fluctuations in the availability of local foods. New and emerging non-thermal technologies, many of which are described by Knorr and Watzke (2019[10]), can improve the retention of various nutrients during processing operations, and thus preserve the nutritional quality of foods. Other processing activities can increase micronutrient contents, such as fortification for example the iodization of salt (Box 6.2). Another example is the use of pulsed UV light to increase vitamin D levels in mushrooms (Cardwell et al., 2018[12]).

While many processing activities make crucial contributions to the availability of safe, affordable and nutritious foods, the end-products of some processing activities can be energy-dense and nutrient-poor, and the excessive consumption of these foods can undermine population health objectives.[7] For example, using 2009-2010 National Health and Nutrition Examination Survey data and the NOVA classification to group dietary patterns in the United States into quintiles based on the energy contribution from ultra-processed foods, Steele et al. (2017[13]) found that diets with a higher energy contribution from ultra-processed foods are on average lower in protein, fibre, vitamins A, C, D, and E, zinc, potassium, phosphorus, magnesium, and calcium, and higher in carbohydrates, added sugar, and saturated fat contents. Another study, which used data from the United States 2000-2007 Homescan Panel and classified purchases of consumer packaged goods by degree of industrial processing and convenience, found higher saturated fat, total sugar, and sodium content among highly processed purchases compared to less processed purchases and ready-to-eat purchases compared to foods that required cooking or preparation (Poti et al., 2015[14]). This study also reported substantial variability in nutrient content within categories of consumer packaged goods, highlighting the potential importance of food choices within product categories. Several features of dietary patterns with excessive contributions from energy-dense and nutrient-poor processed foods correspond to some of the dietary risk factors listed in the 2017 Global Burden of Disease study (Afshin et al., 2019[1]). Some examples of these dietary risk factors include a diet low in fibre and calcium, and high in sodium and trans fatty acids. Other studies have also indicated that high sugar intake poses health risks (Box 6.2).

Economic development and income growth are associated with a dietary transition towards increased consumption of sugars and refined carbohydrates, salts, and oils and fats via some types of processed foods (Popkin, 2017[15]).[8] Several studies using the NOVA classification show that the consumption of ultra-processed foods accounts for a large share of total dietary energy intake among many high-income countries, and that their sales are growing rapidly in middle-income countries (Baker and Friel, 2016[16]; Monteiro et al., 2019[4]; Monteiro et al., 2013[17]; Sievert et al., 2019[18]; Popkin, 2014[19]). For example, national food consumption data for children and adults in the United States, Canada, Australia, and Chile reveal that ultra-processed foods are responsible for 60%, 48%, 42%, and 29% respectively of total dietary energy (Moubarac, 2017[20]; Baraldi et al., 2018[21]; Cediel et al., 2017[22]; Machado et al., 2019[23]).[9] Recent analysis of NutriNet-Santé cohort data from France revealed that ultra-processed foods contributed to 36% of dietary energy (Julia et al., 2017[24]). In the United Kingdom, ultra-processed foods accounted for 51% of calories purchased in 2008 (Monteiro et al., 2017[25]). Although processed foods high in sodium, free sugars, or fats are associated with adverse health effects when consumed in excess, it is important to note that other ingredients or additives can provide various positive functions, such as preservation or an increase in micronutrient content (in the case of fortification).

Problems associated with poor diet quality have become increasingly prevalent at the global level. For instance, the global prevalence of obesity among children aged 5-19 years increased more than five-fold between 1975 and 2016 (Abarca-Gómez et al., 2017[26]). In G20 countries, the rate of obesity among children aged 5-19 years increased from an average of 2-3% in 1975 to about 10% in 2016. Nearly one-quarter of people in OECD countries were categorised as obese in 2016 (OECD, 2019[27]), and conditions related to overweight and obesity account for approximately 8% of total health expenditure in OECD countries today (OECD, 2019[27]).

Shifts in dietary patterns are not solely responsible for these trends; other factors include level of physical activity, genetic characteristics, and microbiota (Graf and Cecchini, 2017[28]; Valdes et al., 2018[29]). Yet, it seems likely that the growing consumption of energy-dense and nutrient-poor processed food is an important contributing factor to the higher prevalence of overweight, obesity, and specific forms of cancer and other NCDs (WHO and FAO, 2002[30]; Fiolet et al., 2018[31]; Popkin and Gordon-Larsen, 2004[32]; Poti, Braga and Qin, 2017[9]; Schnabel et al., 2018[33]). A recent in-patient randomised controlled trial study demonstrated a causal relationship between the consumption of ultra-processed foods and excess calorie intake and weight gain, although further evidence based on a larger sample and over a longer period of time will be necessary to verify and support the results (Hall et al., 2019[34]).

Box 6.2. Effect of sugar, salt, and trans fat consumption on health

Sugars, salt and oils and fats are ingredients found in processed foods. To minimise health-related risks, the World Health Organisation (WHO) recommends limiting the intake of salt to less than 5g per day, of free sugar to less than 10% of total energy intake, and of saturated fat to less than 10%, and of trans fat to less than 1% of total energy intake. Overconsumption of each of these has been linked to various negative health outcomes (WHO, 2020[35]).

- High sodium intake (typically via salt intake) increases one's risk of hypertension, cardiovascular disease, and stroke (WHO, 2020[35]). Salt can be used in processed foods as a preservative, binding agent, and flavour enhancer. The 2017 Global Burden of Disease Study identified the high intake of sodium as among the leading dietary risk factors for deaths and disability-adjusted life-years (DALYs), accounting for 3 million deaths and 70 million DALYs worldwide (Afshin et al., 2019[1]).
- Free sugars are defined by the WHO as follows: "monosaccharides and disaccharides added to foods and beverages by the manufacturer, cook or consumer, plus sugars naturally present in honey, syrups, fruit juices, and fruit juice concentrates." (WHO, 2015[36]). High intake of free sugar is associated with poor dietary quality, and a higher risk for overweight, obesity, specific forms of cancer and other NCDs, and dental caries (WHO, 2015[36]).
- Saturated fats that are mainly sourced from animal products, dairy and meat, salmon, egg yolks and some plant products (e.g. chocolate, cocoa butter) when consumed excessively have been associated with cardiovascular disease and coronary heart disease, ischemic stroke, and type 2 diabetes (The Global Burden of Diseases Nutrition and Chronic Diseases Expert Group (NutriCoDE), 2016[37]; de Souza et al., 2015[38]; SACN, 2019[39]; Dietary Guidelines Advisory Committee, 2020[40]; Health Canada, 2019[41]).

Trans fats or trans fatty acids are a type of unsaturated fat typically produced through an industrial process (partial hydrogenation). A large body of evidence links the intake of industrially-produced trans fatty acids to an increased risk of coronary heart disease and related mortality (Nishida and Uauy, 2009[42]; WHO, 2019[43]; The Global Burden of Diseases Nutrition and Chronic Diseases Expert Group (NutriCoDE), 2016[37]; de Souza et al., 2015[38]).

Processed foods have an important role in supporting food access

Food access is not equivalent to food availability. Food availability is a prerequisite for food access, and refers to the existence of a sufficient supply of food within a given location (FAO, 2006[44]). Food access takes into account additional characteristics of the food environment, including spatial factors such as travel distance to stores where food is purchased and access to transportation (e.g. access to a personal vehicle, access to public transportation), and embeds the concept of affordability (e.g. food prices, real incomes, cost of transportation) (Chenarides and Jaenicke, 2018[45]). The assortment of accessible foods varies across space, and, in turn, processed foods make varying contributions to overall dietary patterns across different food environments.

An emerging body of research, largely limited to North America at present, has begun to investigate the spatial relationships between public health outcomes and access to different types of foods.[10] The term "food desert" has emerged from this research. Presently, there is no consensus on the precise definition of a food desert, but the term generally refers to an area devoid of supermarkets with a resulting lack of access to nutritious and affordable foods (Ploeg et al., 2009[46]) (Walker, Keane and Burke, 2010[47]). Residents in such areas may have greater exposure to energy-dense and nutrient-poor processed foods due to the relative prevalence of convenience stores and fast-food outlets (Drewnowski and Specter, 2004[48]; Walker, Keane and Burke, 2010[47]). In line with this, a recent study using retailer scanner data from 2010-2015 in the United States found that consumers in areas with poor food access were also faced with fewer fruit and vegetable product options (referring to food items such as bagged produce, frozen fruits and vegetables, and shelf stable or canned fruits and vegetables) (Chenarides and Jaenicke, 2018[45]). In these areas, processed and shelf-stable options, such as frozen or dried fruits and vegetables among others, may be valuable for delivering many key micronutrients to consumers.

Existing evidence does not discern a clear causal relationship between food deserts and higher intake levels of processed foods. There is the possibility that local food environments reflect underlying food preferences. In line with this supposition, research has demonstrated that improving access to safe, affordable and nutritious food options by building new supermarkets in food deserts does not necessarily induce shifts towards dietary patterns that support population health objectives (Dubowitz et al., 2014[49]; Ver Ploeg and Rahkovsky, 2016[50]). Instead, taste preferences and other socio-economic factors may play a greater role in food choices.[11] Thus, eliminating food deserts by improving access to safe, affordable and nutritious food options may not be sufficient to curb intake levels of energy-dense and nutrient-poor processed food products.

An additional term that has emerged from research investigating food environments is "food swamp". This refers to an area with a high density of foods that contribute to the excess intake of sodium, free sugars, and fats on a regular basis. This is distinct from the concept of a food desert in that safe, affordable and nutritious food options are accessible but outnumbered by an abundance of energy-dense and nutrient-poor food items. A US study suggests that food swamps may be stronger predictors of obesity than food deserts, and zoning policies are proposed as a way to address the over-abundance of energy-dense and nutrient-poor processed food options (Cooksey-Stowers, Schwartz and Brownell, 2017[51]). The food environment extends to "commuter corridors" and food options in the vicinity of people's work places (Dornelles, 2019[52]) (Burgoine et al., 2014[53]). Public policy could help to encourage retail outlets to provide and promote safe, affordable and nutritious processed or unprocessed food options.

Remote and isolated communities may struggle with poor food access, which can increase their reliance on certain processed foods that are potentially unhealthy, such as those high in sodium, free sugars, and/or some fats. For instance, in many communities across northern Canada, fresh fruits and vegetables are either unavailable or unaffordable due to long travel distances and the high costs associated with transporting food items to remote communities (Council of Canadian Academies & Expert Panel on the State of Knowledge of Food Security in Northern Canada, 2014[54]). In such cases, lower-cost food items may include energy-dense and nutrient-poor processed foods. In recent decades, communities across northern Canada have experienced a dietary shift towards increased consumption of such processed foods.[12]

Food fortification as a means to address micronutrient deficiencies

In some cases where inadequate diets have resulted in micronutrient deficiencies within particular populations, food fortification has been employed as a corrective measure. Fortification refers to the deliberate addition of micronutrients to foods and has been used to address micronutrient deficiencies in both developed and developing countries. Efficient fortification programmes require co-ordination with the food processing industry, as well as the development of quality standards with monitoring to ensure that the levels of added micronutrients are effective while remaining below a determined intake level. International co-ordination is also important in order to prevent different stances that would result in unnecessary barriers to trade. Box 6.3 outlines a few examples of fortification programmes that have been implemented.

Similarly, "functional foods" have been suggested as a means to convey physiological benefits to consumers. However, unlike fortified foods, there is no consensus on the definition of a "functional food". Broadly speaking, the foods that might be referred to in some contexts as 'functional' typically contain particular ingredients (such as vitamins, minerals, and bioactive compounds) at levels high enough to potentially impart physiological benefits to consumers. Examining the regulatory environment surrounding health claims for these products and other food products will be an important area for future work, along with more research to better understand their health impacts. [13] International alignment on defining foods that might be considered 'functional' is also important.[14]

Box 6.3. Food fortification programmes and the processed food sector

Iodine fortification

Iodine deficiency is a major public health challenge that affects approximately two billion people worldwide (Biban and Lichiardopol, 2017[55]). Iodine is a mineral required for the synthesis of thyroid hormones; its deficiency can cause a range of adverse health outcomes, collectively referred to as iodine deficiency disorders. Adequate amounts of iodine can be difficult to obtain through diet alone due to the prevalence of iodine-poor soils used to grow crops. Universal salt iodization has been recommended and is endorsed by the WHO, but current voluntary and mandatory fortification programmes only reach approximately 71% of the global population. Despite well-documented improvements in public health outcomes, some countries prohibit the iodization of salt and the use of iodized salt in processed foods, with implications for trade in such products (Charlton and Skeaff, 2011[56]). On the other hand, with salt as the primary vehicle for iodine fortification, concerns have been raised over policies that aim to decrease dietary sodium. The potential impact of these policies is not yet clear, although much of the research to date suggests that the two objectives are compatible (Pastorelli, Stacchini and Olivieri, 2014[57]; Verkaik-Kloosterman, van 't Veer and Ocké, 2010[58]; Zimmermann, 2011[59]).

Folic acid fortification

Folic acid is the synthetic form of the water-soluble vitamin folate. Inadequate consumption of folate among women is associated with an increased risk of neural tube defects among newborns. Folic acid fortification programmes have been implemented in many countries and are considered to have been largely successful. For example, the United States and Canada implemented mandatory cereal grain fortification programmes in 1998, and Chile legislated mandatory folic acid fortification of wheat flour beginning in 2000 (Hertrampf and Cortes, 2004[60]; Crider, Bailey and Berry, 2011[61]; Ray, 2004[62]). All three countries have seen reductions in the prevalence of neural tube defects at birth. Other countries have employed voluntary fortification programmes. For example, the New Zealand Food Standard issued in 2012 permitted voluntary fortification of bread with folic acid (New Zealand Government, 2018[63]), and consultations are currently underway to introduce mandatory folic acid fortification (New Zealand Government, 2019[64]).

Vitamin D fortification

Vitamin D is important for regulating blood calcium levels and gene expression, and ensuring the proper growth and maintenance of bone tissue; inadequate intake is associated with rickets in children and osteomalacia in adults. Vitamin D is normally obtained via sun exposure and the consumption of animal-sourced foods (Pilz et al., 2018[65]). Its deficiency is a public health concern worldwide (Palacios and Gonzalez, 2014[66]) and many countries have either a voluntary or mandatory fortification programme in place; mass fortification programmes are in place in the United States, Canada, and Finland (Pilz et al., 2018[65]). A recent review of the Finnish fortification programme introduced in 2003 revealed substantial improvements in the vitamin D status of adults between the years 2000 and 2011 (Jääskeläinen et al., 2017[67]).

HarvestPlus

HarvestPlus[1] and its partners work towards improving human health and nutrition by developing and promoting biofortification technologies. In particular, HarvestPlus uses biofortification as a means to increase the zinc, iron, and vitamin A content in various staple crops. This method is effective in addressing micronutrient deficiencies (Bouis and Saltzman, 2017[68]). In contrast to industrial food fortification technologies, the biofortification of crops is accomplished through processes such as plant breeding, certain agronomic practices, and transgenic techniques (discussed in further detail in the seed sector case study). In this way, the fortification process actually takes place before any food processing. Food processors still play a key role in advancing food product value chains by including these crops as ingredients in their food products. This requires that the food processing sector provide for R&D spending towards the testing of biofortified crops in order to investigate, for example, vitamin and mineral retention by crops following various processing techniques.

1. More information on HarvestPlus can be found at https://www.harvestplus.org.

Marketing and R&D both play a major role in the processed food sector

Many food and beverage companies report substantial advertising expenses. For example, Coca-Cola Co. reported USD 4.1 billion in advertising expenses worldwide in 2018 (approximately 13% of net operating revenue) (The Coca-Cola Company, 2018[69]). Likewise, 2018 annual reports from the multinational companies PepsiCo and Kellogg Company show marketing and advertising expenditures of USD 4.2 billion and USD 752 million, respectively (approximately 6% of net revenue for each firm) (PepsiCo, 2018[70]; Kellogg Company, 2018[71]). In 2016, Nestlé spent USD 9.2 billion on all advertising (including television, in-store and social media), an amount equivalent to approximately 10.3% of that year’s sales. Nestlé was ranked third globally in the top 100 companies spending the most on advertising in 2016 (AdAge, 2017[72]; Nestle, 2017[73]). Seven firms from the food and beverage sector (excluding restaurants and alcohol) were included in the top spending 100 firms with a combined USD 23 billion spent on advertising (AdAge, 2017[72]).

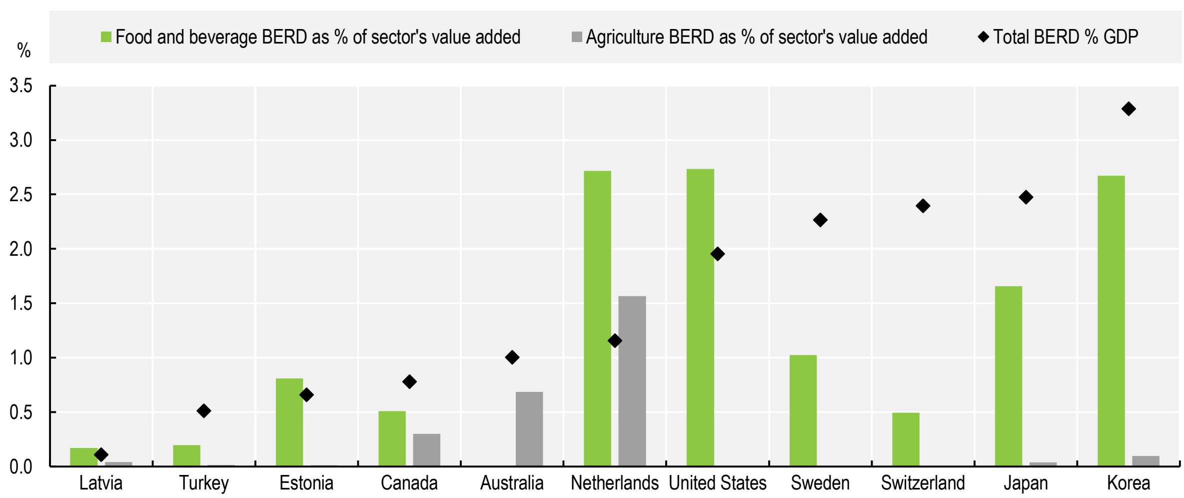
Marketing of processed food products is one way to communicate important information to consumers. However, there is growing concern about the exposure of children to the marketing of foods in so far as it contributes to excess intake of sodium, free sugars, and fats. These concerns stem from the evidence that such marketing can influence the preferences and consumption patterns of children (Cairns et al., 2013[74]; Sadeghirad et al., 2016[75]; Norman et al., 2018[76]; Boyland et al., 2016[77]; Harris, Bargh and Brownell, 2009[78]).

Evidence on the impact of food marketing on the consumption behaviour of adults is mixed. For example, a meta-analysis from Boswell and Kober (2015[79]) shows the association between visual food cues and subsequent eating behaviour and weight gain. Other research suggests that intense exposure to food advertising of products high in sodium, sugar, or fat does not influence food intake in adults but is associated with increased food intake in children (Boyland et al., 2016[77]). Voluntary self-regulation schemes have been favoured as a means to address the marketing of processed foods that are potentially unhealthy, such as those high in sodium, free sugars, and/or some fats, but there is little evidence to support their effectiveness (Moodie et al., 2013[80]; Stuckler and Nestle, 2012[81]).

While marketing strategies may influence preferences for existing processed food products, R&D expenditure influences the types of processed foods that will become available in the future, and hence plays an important role in shaping the food environment. Historically, public R&D investments have dominated total R&D expenditure in food and agriculture. However, the private share of worldwide agriculture and food R&D grew from 36% in 1980 to 44% in 2009, with recent data indicating continued expansion (Pardey et al., 2015[82]). Food processing accounts for more than half of private spending on food and agriculture-related R&D (Fuglie, 2016[83]; Pardey et al., 2015[82]; Bientema et al., 2012[84]). Business expenditures on R&D (BERD) as a percent of gross value added in the agriculture and food and beverage sectors are presented in Figure 6.1 for several OECD countries, as an indicator of the research intensity within those countries and sectors.

Figure 6.1. Research intensity in the agriculture and food and beverage processing industry, 2016

Business expenditures on R&D (BERD)[1] as a percentage of gross value added



Notes: * Or most recent available year; food and beverage data are not available for Australia; agriculture data are not available for Sweden, Switzerland, and the United States.
1. Business Expenditure on R&D (BERD) is the measure of intramural R&D expenditures within the business enterprise sector (regardless the sources of R&D funds).
Source: OECD (2019), Innovation, Productivity and Sustainability in Food and Agriculture: Main Findings from Country Reviews and Policy Lessons, OECD Food and Agricultural Reviews, OECD Publishing, Paris, https://dx.doi.org/10.1787/c9c4ec1d-en.

For all countries included in Figure 6.1 for which data were available for both sectors, research intensity was higher in the food and beverage sector than in the agriculture sector. Within the food and beverage sector, research intensity was highest in Korea, the Netherlands, and the United States. High research intensity within countries is linked with large multinational companies (Day-Rubenstein and Fuglie, 2011[85]). In cases where national food and beverage companies dominate, previous OECD work suggests that the associated low research intensity may be due to the high costs of conducting research locally, small local market size, regulatory burdens and inconsistencies, or intellectual property protection (OECD, 2019[86]).

These measures of research intensity, however, do not provide any indication of the objectives of R&D expenditures, e.g. is research directed towards increasing the palatability of food items or to test the retention of micronutrients following various transformations. More data are needed to understand how public and private R&D expenditure in the food and beverage sector can facilitate innovations that help the processed food sector maximise its contribution to meeting the triple challenge.

6.3. Livelihoods

The processed food sector offers opportunities for value addition and employment

Economic activities related to food processing account for an important share of income generation (value added) and employment worldwide. Value added from food and beverage manufacturing was an estimated USD 750 billion in 2015, accounting for approximately 1% of world gross domestic product (GDP), but this figure does not take into account the substantial informal sector in developing countries.[15] Moreover, the relative importance of the sector varies with the level of economic development.

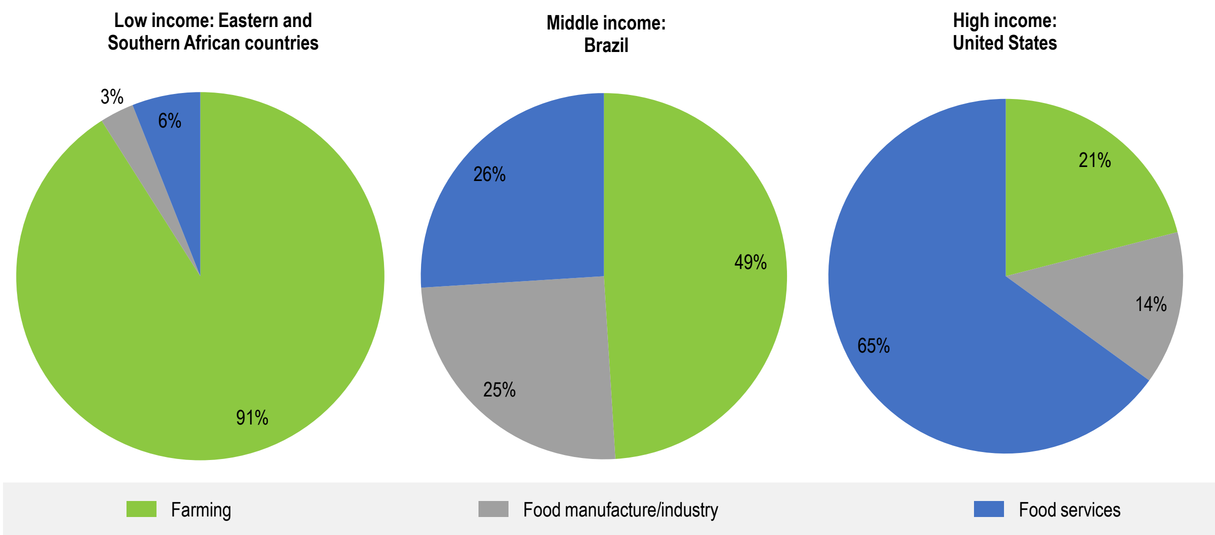
As discussed in Chapter 1, as economies develop the share of total employment in agriculture decreases and a growing share of workers seek employment in downstream sectors, both within and outside the agro-food value chain (Barrett, Carter and Timmer, 2010[87]; Brooks, 2012[88]; Reardon and Timmer, 2012[89]; The World Bank, 2017[90]). This agricultural transformation, alongside the increase in processed food consumption that comes with rising incomes and the need for the preservation of foodstuffs as countries become more urbanised (Popkin, 2017[15]; Wilkinson and Rocha, 2008[91]), lends increasing importance to downstream sectors in the food chain, including the processed food sector. While food manufacturing accounts for just 3% of food system employment across a sample of low-income eastern and southern African countries, this share increases to 25% in Brazil (a middle-income country) and declines to 14% in the United States (a high-income country) as more employment shifts towards food services (covering activities such as the distribution, marketing, and sales of food) (Figure 6.2).

Food and beverage is the leading sector in terms of manufacturing value added in 16 OECD countries and in 2017 ranked among the top three manufacturing sectors in 27 OECD countries (Table 6.1).[16] Across OECD countries that same year, the food and beverage manufacturing sector employed approximately 9.5 million people. Meat processing/preserving accounts for a relatively large share of employment in manufacturing across many OECD countries (Table 6.2).

The food and beverage sector is also the largest manufacturing sector and the leading employer in the European Union (FoodDrinkEurope, 2019[92]), accounting for a 12.3% share of value added in manufacturing and employing 4.7 million people in 2019, with SMEs responsible for most of this employment. In the United States, the Food Dollar Series maintained by the United States Department of Agriculture shows that food processing and packaging accounts for a substantial share of the final value of food products, contributing 17 cents of each dollar spent on food — second only to the food services sector. When considering only food consumed at home, food processing and packaging accounts for the largest share of value added (27.8%).[17]

At the global level, there has been increasing levels of vertical co-ordination of agro-food markets and an increased role for multinational companies (Swinnen and Maertens, 2007[93]; ILO, 2007[94]). The world's top ten food, beverage and tobacco companies generated over USD 539 billion in revenues and employed over 1.2 million people in 2019 (Table 6.3).

Figure 6.2. Composition of food system employment in low-, middle-, and high-income countries



Source: The World Bank (2017), http://documents.worldbank.org/curated/en/406511492528621198/pdf/114394-WP-PUBLIC-18-4-2017-10-56-45-ShapingtheFoodSystemtoDeliverJobs.pdf.

Table 6.1. Performance of the food and beverage manufacturing industry

Selected OECD countries, 2017

Country	Value added (million USD at current prices)	Value added share of manu-facturing (%)	Ranking within manu-facturing sector[1]	Value added share of GDP[2] (%)	Number of employees	Employment share of manu-facturing (%)	Labour productivity (value added USD per employee)[3]
Australia							
Total: Food, beverage, and tobacco	19 193	25.17	1	1.44	244 987	29.50	78 343
Food and beverage	..	..		..	..	..	..
Tobacco products	..	..		..	..	..	..
Canada							
Total: Food, beverage, and tobacco	32 824	17.81	1	1.99	281 780	17.6	116 488
Food and beverage	*31 545*	*17.12*		*1.92*	*279 723*	*17.47*	*112 772*
Tobacco products	*1 279*	*0.69*		*0.08*	*2 057*	*0.13*	*621 779*
Chile							
Total: Food, beverage, and tobacco	..	..	1	..	..	..	..
Food and beverage	*10 327*	*40.47*		*3.72*	*165 828*	*39.12*	*62 275*
Tobacco products	..	..		..	..	..	..
France							
Total: Food, beverage, and tobacco	45 190	17.58	1	1.75	..	..	..
Food and beverage	*44 498*	*17.31*		*1.72*	623 256	22.12	71 396
Tobacco products	*692*	*0.27*		*0.03*	..	..	..
Korea							
Total: Food, beverage, and tobacco	31 238	6.83	5	2.04	204 623	7.14	152 661
Food and beverage	*29 130*	*6.37*		*1.90*	*202 549*	*7.07*	*143 817*
Tobacco products	*2 108*	*0.46*		*0.14*	*2 074*	*0.07*	*1 016 393*

Country	Value added (million USD at current prices)	Value added share of manu-facturing (%)	Ranking within manu-facturing sector[1]	Value added share of GDP[2] (%)	Number of employees	Employment share of manu-facturing (%)	Labour productivity (value added USD per employee)[3]
United Kingdom							
Total: Food, beverage, and tobacco	42 647	18.96	1	1.60	482 625	19.13	88 365
Food and beverage	..	..		..	*482 245*	*19.12*	..
Tobacco products	..	..		..	*380*	*0.01*	..
United States							
Total: Food, beverage, and tobacco	403 896	16.18	2	2.07	1 610 898	14.29	250 727
Food and beverage	*368 195*	*14.75*		*1.89*	*1 597 654*	*14.17*	*230 460*
Tobacco products	*35 701*	*1.43*		*0.18*	*13 244*	*0.12*	*2 695 636*
OECD area							
Total: Food and beverage[4]	917 504	13.56		1.84	9 500 003	15.65	96 579

Notes: Where possible, estimates for food and beverages are shown separately from estimates for tobacco products. Not all countries have estimates for both of the categories 'food and beverage' and 'tobacco products'. Other countries have only an aggregate estimate for 'food, beverage, and tobacco'. Beverages include alcoholic beverage products.
1. Ranking is based on value added.
2. Author's calculations using World Bank Development Indicator estimates of GDP (USD at 2017 prices).
3. Author's calculations. Labour productivity is calculated as the ratio of value added to the number of employees for the year 2017.
4. Food and beverage value added and tobacco products value added estimates are aggregated for five OECD countries. Food and beverage employment and tobacco products employment estimates are aggregated for two OECD countries. Estimates for Latvia are from 2016 (the most recent year available).
Source: UNIDO Statistical Country Briefs (ISIC rev3), https://stat.unido.org/app/country/Emp.htm?Country=124&Group=null (accessed February 2020); the World Bank database of World Development Indicators, https://databank.worldbank.org/source/world-development-indicators (accessed February 2020).

Table 6.2. Employment within select sub-sectors of food manufacturing

Selected OECD countries, 2016

	Sub-sector Number employed (employment share of manufacturing, %)					
Country	Processing/ preserving of meat	Processing/ preserving of fruit, vegetables	Dairy products	Bakery products	Cocoa, chocolate and sugar confectionary	Vegetable and animal oils and fats
Australia	62 135 (7.4%)	14 510 (1.7%)	19 437 (2.3%)	70 361 (8.4%)	11 454 (1.4%)	1 628 (0.2%)
Canada	61 293 (3.9%)	18 632 (1.2%)	20 727 (1.3%)	47 344 (3.0%)	8 490 (0.5%)	3 259 (0.2%)[1]
Chile	28 885 (6.7%)	21 723 (5.1%)	13 503 (3.2%)	..	..	2 539 (0.6%)
France	120 462 (4.3%)	24 966 (0.9%)	60 113 (2.1%)	216 510 (7.7%)	19 293 (0.7%)	3 939 (0.1%)
Korea	36 364 (1.3%)	16 268 (0.6%)	10 016 (0.4%)	20 567 (0.7%)	4 465 (0.2%)	1 755 (0.1%)
United Kingdom	70 226 (2.7%)	33 909 (1.3%)	26 014 (1.0%)	94 667 (3.7%)	21 184 (0.8%)	1 410 (0.1%)
United States	479 511 (4.3%)	160 550 (1.4%)	135 821 (1.2%)	252 214 (2.3%)	60 281 (0.5%)	15 746 (0.1%)

Notes: Sub-sectors shown do not constitute the entire food manufacturing sector.
1. This value is the aggregate of 'vegetable and animal oils and fats' (ISIC 1040) and 'starches and starch products' (ISIC 1062).
Source: UNIDO INDSTAT 4 2019 (ISIC rev4), https://stat.unido.org/database/INDSTAT%204%202019,%20ISIC%20Revision%204 (accessed February 2020).

Table 6.3. Top 10 global food, beverage and tobacco manufacturing companies by revenues, 2019

Food, beverage, and tobacco company	Revenues (million USD)	Assets (million USD)	Employees	Headquarters
Nestlé	93 512.5	139 045.1	308 000	Switzerland
PepsiCo	64 661	77 648	267 000	United States
Archer Daniels Midland	64 341	40 833	31 600	United States
Anheuser-Busch InBev	54 619	232 103	172 603	Belgium
JBS	49 709.7	29 454.7	230 086	Brazil
Bunge	45 743	19 425	31 000	United States
Wilmar International	44 497.7	45 679.9	90 000	Singapore
Louis Dreyfus	40 571	18 440	16 785	Netherlands
Tyson Foods	49 052	29 109	121 000	United States
CHS	32 683.2	16 381.2	10 495	United States

Note: Beverages include alcoholic beverage products.
Source: Fortune Global 500 (2019), https://fortune.com/global500/2019/search/ (accessed February 2020).

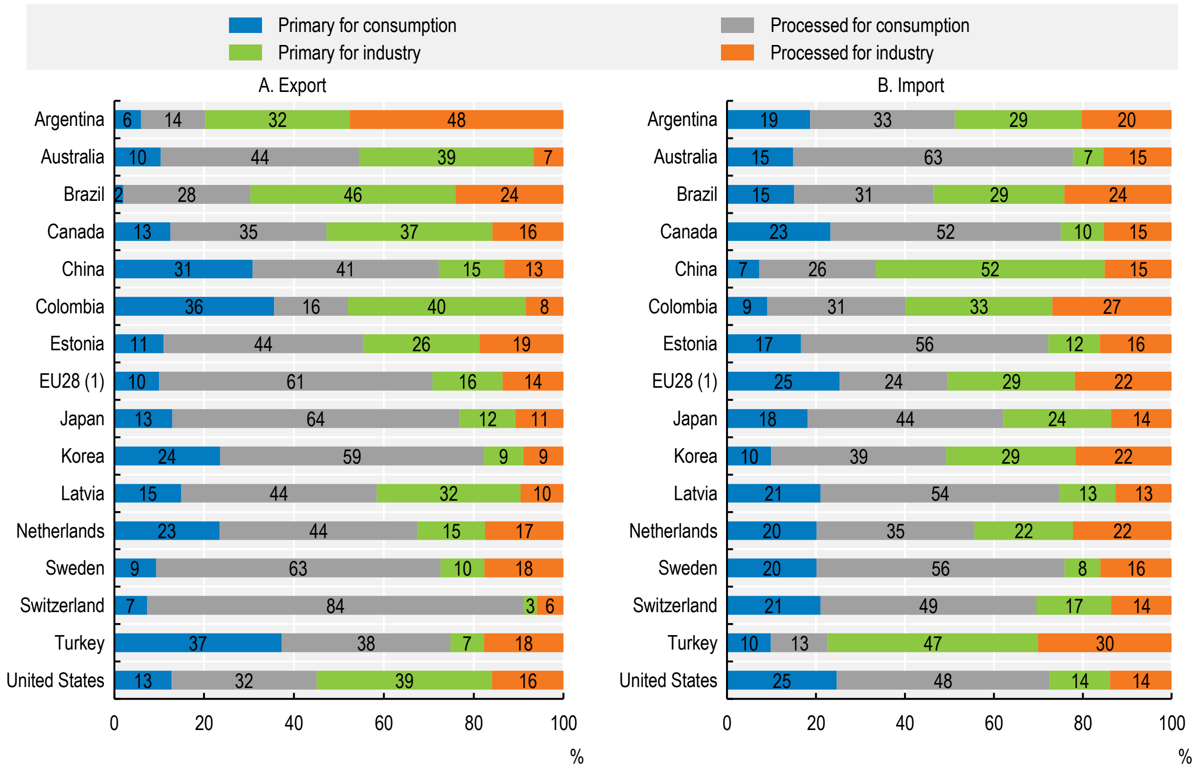
Evidence of consolidation and market concentration in food and beverage manufacturing has raised concerns around the potential for buyer power to negatively impact producer incomes in agricultural product markets. The food chain often exhibits an "hour-glass" shape, with many agricultural producers supplying a smaller number of processors and retailers who in turn provide products to many consumers. One concern is that high levels of market concentration could lead to monopolistic or monopsonistic behaviours. However, at present empirical evidence does not appear to support the hypothesis of systematic exploitation of buyer power by food processing firms (Perekhozhuk et al., 2016[95]; Sheldon, 2016[96]; Sexton and Xia, 2018[97]). However, it should be noted that studies to date do not provide comprehensive coverage across all geographic locations or agricultural product categories.

International trade in processed food products

Food processing plays a key role in the international trade of agro-food products. While some primary agricultural commodities are exported directly for consumption in foreign markets, many others are 1) exported as intermediates for processing in foreign markets, 2) processed domestically and exported for consumption in foreign markets, or 3) processed domestically and exported as intermediates for further processing in foreign markets. In this way, processed food products and intermediate products destined for further processing are dominant in agro-food trading activities in many OECD countries (Figure 6.3).

Current patterns of international trade in processed food products reflect the evolution of food processing technologies, consumer demand for year round access to a wider variety of foodstuffs, longer food chains, and increasing integration into global value chains (GVCs). The trade of processed food products and participation in GVCs has the potential to increase domestic value added and employment opportunities in the processing and agricultural sectors as domestic producers can take advantage of foreign demand for transformed and differentiated food products (Greenville, Kawasaki and Jouanjean, 2019[98]).[18] Evidence about the participation of SMEs in GVCs for agriculture and food products in South East Asian countries suggests that SMEs might struggle to integrate directly into GVCs as buyers or suppliers but they might be increasingly engaging in indirect exporting (selling to domestic firms which then export these products) (López González et al., 2019[99]).

Figure 6.3. Composition of agro-food trade, 2016



Notes: Numbers may not add up to 100 due to rounding. Agro-food definition does not include fish and fish products. Agro-food codes in H0: 01, 02, 04 to 24 (excluding 1504, 1603, 1604 and 1605), 3301, 3501 to 3505, 4101 to 4103, 4301, 5001 to 5003, 5101 to 5103, 5201 to 5203, 5301, 5302, 290543/44, 380910, 382360.1. Extra-EU trade.

Source: OECD (2019), *Innovation, Productivity and Sustainability in Food and Agriculture: Main Findings from Country Reviews and Policy Lessons*, OECD Food and Agricultural Reviews, OECD Publishing, Paris, https://dx.doi.org/10.1787/c9c4ec1d-en.

6.4. Environmental sustainability

Environmental impact of the processed food sector

As discussed in Chapter 1, much of the food system's environmental impact is associated with on-farm production and associated land use change. For example, greenhouse gas (GHG) emissions within the farm gate and from land use changes account for 16-27% of total anthropogenic GHG emissions, compared to just 5-10% from all remaining stages of the global food system together (IPCC, 2019[100]).

Yet complex linkages exist between the agriculture sector and its downstream sectors. As the food processing sector is at the interface of supply and demand, it can play a key role in shaping environmentally sustainable production and consumption patterns, e.g. by requiring improved sustainability monitoring and performance by suppliers and by providing consumers with information on performance (Poore and Nemecek, 2018[101]).To support this type of re-orientation, OECD-FAO (OECD/FAO, 2016[102]) outlined a framework to assist enterprises involved in food and agriculture to engage responsibly with their supply chains, as discussed in Chapter 2.

While farm level practices are responsible for much of the observed negative environmental impact of food systems, downstream sectors also make significant contributions. Overall, food processing accounts for an estimated 4.4% of GHG emissions, 2.4% of terrestrial acidification, and 1.7% of freshwater and marine eutrophication (Poore and Nemecek, 2018[101]). These negative environmental impacts – GHG emissions in particular – are due in part to the high energy requirements of the food processing sector (OECD, 2017[103]).

Improvements in efficiency could lower energy costs and reduce negative environmental impacts. Recent management practices and technological innovations have led to improvements in energy efficiency, leading to reductions in emissions. For example, the Food and Drink Federation in the United Kingdom reported a decrease in carbon dioxide emissions in 2017 of 53% from their 1990 baseline (Food and Drink Federation, 2018[104]).[19] There is scope, however, for further efficiency gains (Tassou et al., 2014[105]; Chowdhury et al., 2018[106]). OECD (2017[103]) identified several barriers to adopting energy efficient practices and technologies in the food supply chain, including structural barriers (e.g. lack of know-how), behavioural barriers (e.g. informational market failures that inhibit the pursuit of energy-efficient opportunities), availability barriers (e.g. inadequate access to energy-efficiency measures), and policy barriers (e.g. energy subsidies that distort market prices and fail to incentivise energy efficiency).[20]

Changes in dietary patterns and environmental sustainability: Implications for the processed food sector

Environmental impacts vary across different food groups, and a growing body of research is investigating the connections between dietary patterns and environmental degradation (Clark and Tilman, 2017[107]; Springmann et al., 2018[108]). The growing concern over the environmental impacts of dietary patterns has led to calls to incorporate sustainability concepts into dietary guidelines, recommendations, and benchmarks (Blackstone et al., 2018[109]; Willett et al., 2019[110]; Gonzalez Fischer and Garnett, 2016[111]). For example, the most recent version of the Dutch dietary guidelines recommends limiting weekly consumption of red meat to 300g or less, specifying that adherence to this limit is ecologically desirable (Health Council of the Netherlands, 2016[112]) (discussed in further detail in the ruminant livestock sector case study). Similarly, the EAT-Lancet reference diet aims to improve both health and environmental outcomes (Willett et al., 2019[110]).

Nutritional outcomes and environmental considerations are different globally. From the ruminant livestock sector case study it is apparent that in many developing countries crops are the main source of protein. For example, consumption of all types of meat is low in Sub-Saharan Africa, Asia and the Pacific. In these regions increased consumption of all proteins, including animal protein, would be optimal for human health and nutrition. However, in developed countries which are large GHG emitters and which consume on average three times as much beef as developing countries the situation is different.

In light of the growing interest in the environmental sustainability of diets, an important consideration in the context of processed foods is whether a transition to dietary patterns supporting population health objectives (e.g. through product reformulation or through substitution with different food options) would improve environmental sustainability.

While there may be synergies between health outcomes and environmental sustainability for some product categories, overall it appears there is only a weak correlation between these two dimensions in the case of highly processed foods. Ingredients common to some highly processed foods — such as sugars, salt, and grains — can have lower environmental impacts per calorie than fruits, vegetables, and animal-sourced foods (Vieux et al., 2013[113]; Garnett, 2016[114]; Drewnowski et al., 2014[115]; Tilman and Clark, 2014[116]). Sugar-sweetened beverages, for example, have a relatively low environmental impact (Clark et al., 2019[117]). Moreover, processing itself is typically not the major contributor to the environmental footprint of food products. Thus a reduction in the consumption of many highly processed foods would be unlikely to contribute to better environmental outcomes.[21]

An important exception is processed red meat; evidence suggests that a reduction in consumption could have environmental and health benefits, although the same evidence suggests similar effects for unprocessed red meat (Clark et al., 2019[117]). New forms of processed foods such as meat analogues and lab-grown foods are now emerging in response to growing concerns over the health and environmental implications of high intake levels of red and processed meats (Box 6.4). The contribution of such food products to the different dimensions of the triple challenge constitutes an interesting area for future research.

Box 6.4. Meat analogues and lab-grown foods: Emerging forms of processed foods

Animal-sourced foods provide energy and protein as well as an array of additional nutrients, and their consumption has historically held cultural and social significance (Macdiarmid, Douglas and Campbell, 2016[118]; Mottet et al., 2017[119]). Optimal nutritional outcomes in some countries, particularly least developed and those with high levels of malnutrition, involve increased consumption of all proteins, including animal protein. However, in developed countries, growing concerns over the health and environmental impact of animal-sourced foods (particularly of red and processed meats) and considerations for animal welfare have led to calls to reduce the consumption of animal-sourced foods and shift towards diets that feature plant-proteins (Aiking and de Boer, 2018[120]; Springmann et al., 2016[121]; Willett et al., 2019[110]). Changing consumer behaviour is challenging though, as consumers may be unwilling to change their consumption habits even when aware of the negative impact associated with certain dietary patterns (Macdiarmid, Douglas and Campbell, 2016[118]). This has fostered a growing interest in the development of substitutes for conventional animal-sourced foods, including plant-based meat analogues (products that imitate the aesthetic and nutritional qualities of meat but using plant-based ingredients), cultured meats (animal tissues produced *in vitro* via cell-culturing technologies; these are not yet commercially available), and dairy product analogues (products created *in vitro* using cellular and acellular culturing technologies).

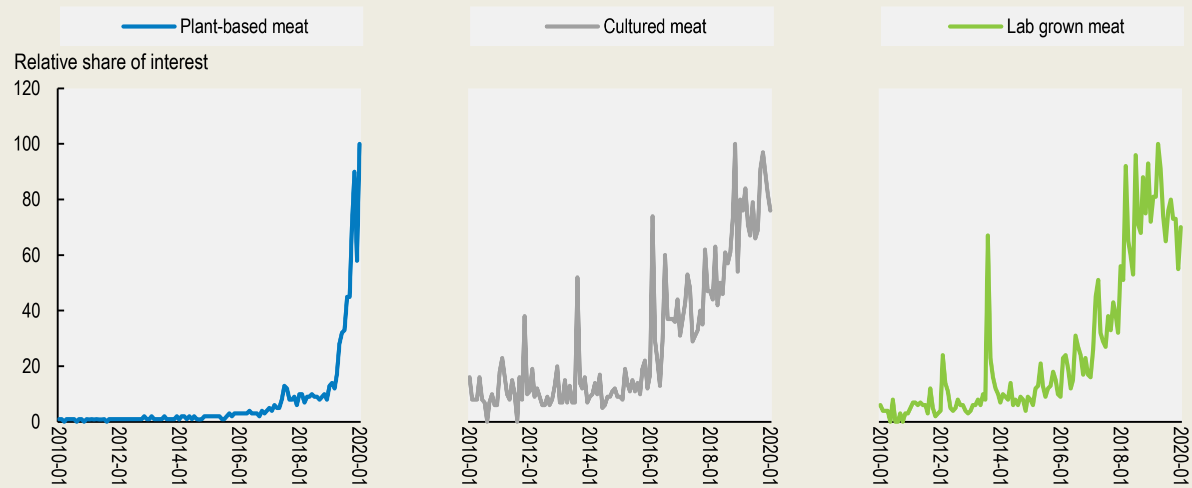
Google Trends data show increasing public interest in the search terms “plant based meat”, “cultured meat”, and “lab grown meat” (Figure 6.4). Companies that manufacture meat analogues and lab-grown foods include Beyond Meat,[1] Impossible Foods,[2] Eat JUST,[3] Solar Foods,[4] Mosa Meat,[5] Memphis Meats,[6] and Nestlé.[7]

Due to the novelty of meat analogues and lab-grown foods, there has been limited research in their market potential or their viability as nutritious, sustainable, and socially acceptable substitutes for animal-sourced foods, including at a global level. Beyond Meat commissioned a life cycle assessment of their *Beyond Burger*, which reported that it generated 90% less GHG emissions, 46% less energy, 99% less water use, and 93% less land use than did a quarter pound of beef produced in the United States (Heller and Keoleian, 2018[122]). Yet plant-based meat analogues can involve a high degree of processing; more research is necessary to understand the level of nutrient and phytochemical retention generated and the overall contributions of such foods to nutrition (Hu, Otis and McCarthy, 2019[123]).

Diets that feature unprocessed or minimally processed plant-based foods, rather than highly processed meat/dairy substitutes, may yield preferable environmental outcomes. A recent study found that, as mentioned above, high processing requirements limit the sustainability gains associated with meat alternatives (van der Weele et al., 2019[124]). Another study reported that plant-based meat analogues have land use requirements that are only marginally lower than requirements for egg and poultry meat production (Alexander et al., 2017[125]). This same study also suggests that cultured meats have similar conversion efficiencies to egg and poultry meat production, but higher energy requirements.

As product formulations and processing and cultivation technologies continue to evolve, further research will be necessary to understand how meat analogues and lab-grown foods will impact food systems.

Figure 6.4. Google keyword worldwide relative search volumes, 2010-2020



Note: Values represent the monthly relative share of interest, normalised to the peak interest for a search term.
Source: Google Trends, https://trends.google.fr/trends/?geo=FR (accessed February 2020).

Notes:
1. https://www.beyondmeat.com/.
2. https://impossiblefoods.com/.
3. https://www.ju.st/en-us.
4. https://solarfoods.fi/#vision.
5. https://www.mosameat.com/.
6. https://www.memphismeats.com/.
7. https://www.nestle.com/media/news/nestle-launch-plant-based-burgers-grounds-us-switzerland.

Even if reducing the consumption of highly processed food does not by itself lead to significant improvements in environmental outcomes, the sheer size and influence of the processed food sector suggests it can play an important role in improving overall environmental sustainability and nutritional quality. This could be achieved by product reformulation, and by requiring stricter environmental standards and the provision of reliable information to allow consumers to choose environmentally-friendly options. Furthermore environmentally harmful subsidies in the food sector which can contribute to negative sustainability outcomes should be addressed, but due to reasons discussed in Chapters 2 and 3 these policies are very hard to reform.

Monitoring changes in the composition of processed food products and the production practices that are associated with sourced ingredients, as well as the implementation of labelling schemes (Box 6.5), will be valuable for evaluating policies that are aimed at improving health and environmental outcomes. New digital opportunities to monitor and share information regarding the environmental impacts associated with various agricultural practices are constantly improving traceability within the agro-food supply chain (The World Bank, 2019[126]; OECD, 2019[127]; Jouanjean, 2019[128]) (Baragwanath, 2021[129]). Efforts to monitor the composition of a range of packaged foods have been undertaken by the global market research company Mintel,[22] and similar databases are being developed by government entities, including the Branded Food Products Database[23] in the United States and the Oqali database[24] in France. Moving forward, it would be helpful to expand such databases to include supply-chain data related to the environmental sustainability of production practices and processes associated with processed food products. Achieving more nutritious and sustainable processed food will also require further innovations in technologies and management practices; public policy can help incentivise such innovations.

Box 6.5. Measuring and communicating the environmental qualities of processed foods

Life cycle assessment

Companies increasingly seek to measure the environmental impacts of their products and services, both for their own use and to communicate these attributes to external users and other stakeholders (Gruère, 2013[130]; Gruère, 2014[131]). For example, companies may track and report carbon footprints (i.e. the quantification of GHG contributions made over the life-cycle of a product or service) or water footprints (i.e. the quantification of fresh water depletion and/or degradation over the life-cycle of a product or service), which involves the use of life cycle assessment (LCA).[1] LCA is a quantitative methodology used to understand the environmental impact of the collection of processes that model the lifecycle of a product within specified system boundaries (i.e. “cradle-to-cradle”, “cradle-to-gate”, “cradle-to-grave”) (Scott Matthews, Hendrickson and Matthews, 2014[132]). In addition to assessing the overall environmental impact, this approach can be used to identify hotspots (i.e. the processes that make the greatest contributions to particular impact categories) in supply chains, which can help companies to prioritise mitigation and innovation efforts. From the policy makers perspective the environmental impacts may lie outside of the food and agricultural area and may be related, for instance, to transport, making things more complex.

Coca-Cola Co. is considered by many to have performed the first LCA in 1969 when making the decision between glass and plastic containers for their beverage products (Scott Matthews, Hendrickson and Matthews, 2014[132]). Since then, this approach has been used to understand the life-cycle impacts of many different food products. For instance, LCA has been used to compare the impact of processed foods against home-made equivalents. One LCA study that compared the carbon footprint of 40 commercial (processed) sandwiches to similar home-made sandwiches found that on average commercially produced sandwiches had carbon footprints twice that of their home-made counterparts (Espinoza-Orias and Azapagic, 2018[133]). Another study comparing the life-cycle environmental impacts of a typical processed ready-made meal with a home-made equivalent found higher GHG emissions associated with the ready-made option (Schmidt Rivera, Espinoza Orias and Azapagic, 2014[134]). Energy requirements for processing and refrigeration and the generation of food loss/waste made substantial GHG contributions for the processed food options in both studies, highlighting the need for further research efforts to reduce their environmental impact. At present, there do not appear to be any studies that have quantified the collective life-cycle impacts of processed food products consumed across the globe.

Environmental labelling and information schemes

Companies use many different schemes to communicate environment-related product/service attributes to users; these schemes are largely voluntary (OECD, 2016[135]). Ecolabel Index, a global directory that tracks ecolabels, lists 463 ecolabels for products and services across the world as of February 2020.[2] Previous OECD work compiled a dataset of environmental labelling and information schemes (ELIS) (Gruère, 2013[130]). This dataset lists 544 ELIS introduced between 1970 and 2012 worldwide. The data shows an increase over time in the number of traditional forms of ELIS (e.g. single-issue environmental seals) as well as the emergence of newer varieties of ELIS (e.g. environmental footprints based on life-cycle approaches). Notably, the majority of ELIS do not rely on LCA as life-cycle approaches are complex, expensive, and may be considered more risky to implement (i.e. there is greater uncertainty around how consumers may react to non-traditional forms of ELIS). The study also described a general lack of transparency in the standard-setting process for most ELIS.

The use of so many different forms of ELIS, especially alongside other types of information (e.g. product nutrition labels, product health claims) can be confusing for consumers, and the use of different methodologies makes it difficult to make valid comparisons across products (OECD, 2016[135]). Evidence also indicates that consumers have limited awareness of environmental labels on consumer goods and that these labels rarely factor into purchasing decisions (OECD, 2016[135]). This was also found to be the case in a study that examined labels such as Fair Trade or Rainforest Alliance used specifically on food products (Grunert, Hieke and Wills, 2014[136]). The influence of ELIS on consumers' food purchasing and consumption behaviour, as well as regulatory responses by governments to the multiplicity of ELIS applied to processed food and beverage products, constitutes an important area for future work.

Notes:
1. The International Organisation for Standardization (ISO) provides guidelines for carbon and water footprinting under ISO 14067 and ISO 14046, respectively (see https://www.iso.org/fr/standard/71206.html and https://www.iso.org/standard/43263.html).
2. See http://www.ecolabelindex.com/.

Waste generation associated with the processed food sector

Food loss and waste

An important share of all food produced for human consumption worldwide ends up as food loss (by actors along the food chain) or food waste (by consumers, retailers and food service providers) (FAO, 2019[137]).[25] Food loss and waste entail the unnecessary consumption of natural resources, represent a lost opportunity to decrease food insecurity, and add to total anthropogenic GHG emissions.

Many factors drive food loss at the processing and packaging stage, including insufficient processing capacity to accommodate seasonal variations in food quantities, technical malfunctions, lack of proper process management, and aesthetic standards (FAO, 2019[138]). While longer and increasingly complex supply chains for processed food products create more opportunities for a diverse market for ingredient suppliers, including at a global level, they can also create more opportunities for food loss/waste between production and consumption. On the other hand, food processing can extend shelf-life, which may help limit food loss and waste downstream. Furthermore, by-products from processing can be used to make other products.

At the processing and packaging stage, food loss varies greatly across different food categories and geographic regions. In the United States and Canada, per capita food loss per year in the food processing sector is estimated to be 47 kg and 43 kg, respectively (Commission for Environmental Cooperation, 2017[139]). According to ranges reported by the Food and Agriculture Organisation (FAO) of the United Nations, food loss at the processing and packaging stage for cereals and pulses could be as high as 16% in Eastern and South-eastern Asia and 20% in Sub-Saharan Africa (FAO, 2019[138]).[26] Food loss for fruits and vegetables during processing also shows geographic variability, with estimates of 0.25% in Central and Southern Asia, 37.5% in Eastern and South-eastern Asia, and 20.5% in Sub-Saharan Africa. Across the globe, approximately 14% of food is lost from post-harvest up to, but not including, the retail stage. It is clear that food loss and waste pose a global challenge. Previous OECD work indicates that many OECD countries address this problem within their waste prevention policies (OECD, 2015[140]).

Policies that influence packaging and date labelling practices (e.g. "use by" or "sell by" dates) used by food manufacturers can impact the quantity of processed food that is wasted at the consumption stage. A common criticism of date labels is that inconsistencies in terminology and information presented across different types of date labels can be confusing and may result in the premature disposal of food based solely on expiration dates (Newsome et al., 2014[141]; Wilson et al., 2017[142]; Wansink and Wright, 2006[143]). An investigation of the influence that different types of date labels and package sizes have on consumers' "willingness to waste" (i.e. anticipated food waste) found varying levels of anticipated waste across date labels and package sizes (Wilson et al., 2017[142]). In particular, higher anticipated food waste was associated with the "use by" label implemented for food safety and health objectives and a larger package size.

Packaging can extend shelf-life and reduce the amount of food loss and waste at various stages along the food supply chain. For example, FoodDrinkEurope reports that 32% of non-packaged produce becomes food waste, compared to 16% of packaged produce (FoodDrinkEurope, 2012[144]). Technologies such as modified atmosphere meat packaging have been effective for extending the shelf-life of meat and poultry products, and thus contribute to the reduction of food loss and waste of these products (Narasimha Rao and Sachindra, 2002[145]) At the same time, the use of packaging for food products can generate greater amounts of packaging waste.

Packaging waste

The generation and mismanagement of plastic waste from food packaging is problematic, in particular as much of it does not biodegrade. If current trends for the consumption and end-of-life management of plastics continue, an estimated 12 000 Mt of plastic waste will enter landfills and the environment by 2050 (Geyer, Jambeck and Law, 2017[146]). Food grade plastics, which must meet quality and purity standards, are challenging to recycle (Watkins et al., 2019[147]; OECD, 2018[148]). As such, a significant portion of the plastic waste stream comes from food packaging. For example, food packaging accounts for approximately 16% of plastic demand each year in the European Union (Schweitzer, Petsinaris and Gionfra, 2018[149]).

Plastic waste typically requires thousands of years to decompose. During this time, it can disrupt and accumulate in marine and terrestrial ecosystems and enter human food supply chains (de Souza Machado et al., 2018[150]; OECD, 2018[148]). Moreover, the production of plastics is energy-intensive and reliant upon fossil fuels (OECD, 2018[148]). In response to evidence on the health and environmental consequences of plastics, particularly single-use plastics, the European Commission released a proposal that included a ban on the use of several single-use plastics by 2021, as well as limitations on the use of plastic food containers and cups (European Commission, 2018[151]). There is also growing interest in developing more sustainable forms of food packaging to replace single-use plastics.[27]

6.5. Policy responses

As Chapter 2 shows, coherent policies require managing both synergies and trade-offs that can emerge across the different objectives for food systems. The following section provides an overview of programmes and policies that target the processed food sector in selected OECD countries in order to gain a better understanding of the approaches that countries have taken to navigate synergies and trade-offs across policy domains, as well as to highlight examples of public-private collaborations.

These examples are discussed within the context of the four-track policy approach developed by OECD (Giner and Brooks, 2019[3]). This approach can be used to reconcile health and nutritional objectives with wider food system objectives, including those related to environmental sustainability and to the livelihoods of agents along the food chain. The first track involves *demand-side public interventions*, such as policies that aim to promote nutritious or more environmentally or socially responsible food choices through the provision of public information. The second track involves *public-private collaborations*. For example, policies may focus on the voluntary reformulation of processed foods in order to provide consumers with more nutritious or sustainable product options. Food and beverage companies may also voluntarily adopt simplified labelling schemes in order to more effectively communicate food product attributes. The third track also focuses on the food industry but involves *stricter regulations*, such as mandatory restrictions on the marketing of foods that are potentially unhealthy, e.g. those that are high in sodium, free sugars, and/or some fats, or bans on the use of certain ingredients in processed food. The fourth track includes *fiscal measures*, e.g. taxes on sugar sweetened beverages. This four-track approach is used here in order to provide insights into the combinations of policy instruments that are likely to be the most effective in addressing the triple challenge with respect to the processed food sector.

Reformulation and orientation towards processed foods that support population health objectives

Measures such as reformulation or reorienting consumers towards processed food options that enable dietary patterns to support population health objectives (e.g. by using public information/education campaigns) have been promoted to address the adverse impacts associated with the consumption of energy-dense and nutrient-poor processed foods. These approaches can be voluntary or mandatory, and have typically focused on reducing dietary intake levels of trans fats, sugar, and salt, based on established links between their consumption and adverse health effects (Box 6.2).

Only a limited number of studies have evaluated the impact of actual reformulation actions undertaken by the processed food sector (Spiteri and Soler, 2017[152]; Poti, Dunford and Popkin, 2017[153]); the vast majority of studies have used simulations to assess the potential impact of hypothetical or proposed reformulation actions (Pearson-Stuttard et al., 2018[154]; Federici et al., 2019[155]; Bruins et al., 2015[156]; Dötsch-Klerk et al., 2015[157]; Hendriksen et al., 2013[158]). This is largely due to a general lack of detailed, product/brand-specific, and up-to-date data on processed food composition (Spiteri and Soler, 2017[152]; Ng and Popkin, 2012[159]). Moreover, existing studies have largely focused on measures for sodium reduction; less is known about the potential population health impacts of reformulation efforts or public information/education campaigns to reduce certain types of fat (i.e. trans fat or saturated fat) intake, sugar intake, and the intake levels of other important nutrients. A recent simulation study in the United States examined how reformulation of packaged foods would affect calories and four nutrients (saturated fat, total sugars, sodium, and dietary fiber), using up-to-date product and purchasing data (Muth et al., 2019[160]). Results showed that reformulation could potentially reduce caloric, saturated fat, sugar, and sodium intakes and increase dietary fibre intake. Detailed data on actual purchasing patterns combined with product/brand-specific food composition data would be particularly helpful to assess the impact of actual, rather than simulated, reformulation actions.

Amongst the criticisms of the reformulation approach is that it does not address overconsumption of foodstuffs – reformulation only addresses the intake of specific food components – and by honing in on specific food components, it overlooks the contributions from other ingredients in processed food products and ignores the potential adverse effects of the substitution of new ingredients (e.g. artificial sweeteners in lieu of sugar) (Scrinis and Monteiro, 2017[161]).

This section discusses OECD country examples of reformulation measures and initiatives to re-orient consumers towards processed food products that support population health objectives.[28]

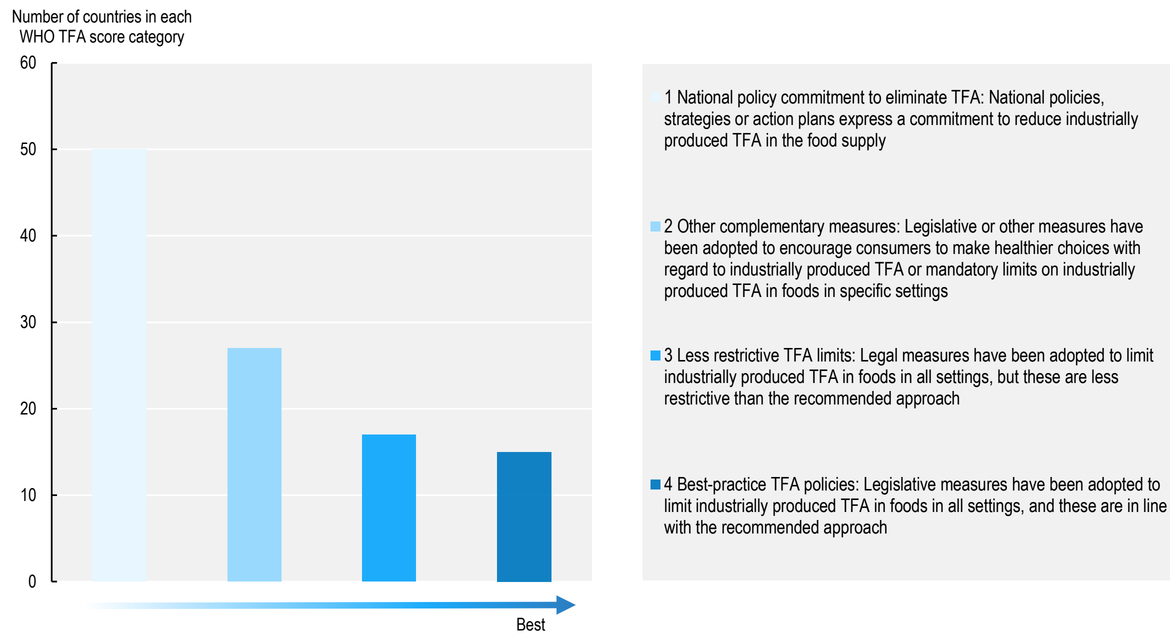
Policies to reduce and eliminate trans fats

Industrial trans fats are produced through partial hydrogenation and have been used, replacing saturated fats from animal products, as a low cost ingredient to prolong shelf life and enhance flavour and/or texture in processed foods such as baked foods, fried foods, snack foods, and spreads (WHO, 2019[162]). In response to the large health burden associated with the intake of trans fats, the WHO launched its REPLACE action package in May 2018 with the aim to "support governments to eliminate industrially-produced trans fats from the global food supply by 2023" (WHO, 2019[163]).[29]

To complement this action and to track progress towards the 2023 target, WHO developed a scoring system that groups trans fats elimination measures into four levels, with the fourth level comprising best-practice policies. Based on data available in the Global Database on the Implementation of Nutrition Action

(GINA), as of February 2020 only 15 countries have best-practice policies (Figure 6.5), while 27 countries have best-practice policies that have passed in legislature but are not yet in effect.

Figure 6.5. Progress towards reducing and eliminating industrial trans-fatty acids



Note: TFA stands for trans-fatty acid.
Source: WHO GINA database, TFA Country Scorecard, https://extranet.who.int/nutrition/gina/en/scorecard/TFA.

Two countries in the "best practice" category are Canada and the United States. A total ban on the sale of foods containing partially hydrogenated oils (and hence trans fats) was implemented in Canada in September 2020 (Health Canada, 2018[164]). This ban applies to domestic and imported foods, and to all food sold in all restaurants. The law was announced two years before its implementation to allow industry time to adapt.

In the United States, the Food and Drug Administration (FDA) ruled trans fats unsafe to eat in 2015 and set a June 2018 deadline by which foods containing trans fats were to be removed from the food system (US FDA, 2018[165]). According to the Grocery Manufacturers Association, 98% of trans fats were removed from the food supply between 2015 and 2018 (Dewey, 2018[166]). Nevertheless, due to concerns from the food industry with the various challenges of eliminating trans fats serving particular functions, it was requested that trans fats be permitted in some circumstances as flavour enhancers or greasing agents (Dewey, 2018[166]), and the ban was delayed. In 2018, a one-year extension to June 2019 was granted for the removal of trans fats from the food system (US FDA, 2018[165]).

More research is needed to gauge the success of the Canadian and United States' programmes. There is concern that such bans will prompt manufacturers to replace trans fats with sources of saturated fats (which are functionally similar to trans fats and have been associated with negative health effects) such as palm oil (Box 6.6) (Kadandale, Marten and Smith, 2018[167]). This highlights the need to monitor and better understand the potential adverse effects (e.g. health, environmental, and/or social) of substitute ingredients following reformulation efforts. Research in Canada (prior to the implementation of the trans fats ban) examining reformulation efforts by some manufacturers to reduce trans fat content in processed food found no increase in saturated fat content following reformulation, suggesting that these manufacturers did not turn to saturated fats as a replacement for trans fats (Ratnayake, L'Abbe and Mozaffarian, 2008[168]). However, more research is needed to better understand how manufacturers respond to total bans on industrially-produced trans fats, and how these responses differ across different country contexts.

Box 6.6. Palm oil and processed foods

Palm oil, a rich source of saturated fats, is a common ingredient in processed food products and many other consumer goods, with some 66 Mt produced in 2017 (Kadandale, Marten and Smith, 2018[167]). Indonesia and Malaysia are the world's main suppliers of palm oil and its production has helped to support the livelihoods of many farmers in these countries. Palm oil has a similar functionality to trans fats when included as an ingredient in various processed foods and there are expectations that manufacturers will increase their use of palm oil when faced with restrictions on the use of trans fats. This has raised concerns due to associations between consumption of palm oil and its adverse effects on health and the environment. Palm oil consumption is linked with higher ischaemic heart disease mortality rates (Chen et al., 2011[169]) and production practices (e.g. slash-and-burn) have additional negative health impacts for individuals living within palm oil production regions (Karthik et al., 2017[170]; The World Bank, 2016[171]). Palm oil production has also prompted large-scale deforestation (Kadandale, Marten and Smith, 2018[167]). A decrease in demand from food manufacturers to support health and/or environmental objectives could therefore have negative impacts on the livelihoods of many Indonesians and Malaysians. On the other hand, potential increases in demand in response to restrictions on the use of trans fats could further support livelihoods in palm oil-producing countries. This underscores the importance of efforts such as the Round Table on Sustainable Palm Oil (RSPO) to improve the environmental performance of the sector and to address concerns related to livelihoods and food security amongst rural populations in palm oil producing regions.

Sugar reduction programme in the United Kingdom

In the United Kingdom, one-third of children are overweight or obese by the time they have finished primary school. Obesity is a major cost to the national health care system (an estimated GBP 6.1 billion per year) (Public Health England, 2018[172]) and in response to this problem, Public Health England (PHE) instituted the Sugar Reduction Programme. This programme challenged the food industry to reduce sugar in their products by 20% by 2020, primarily by providing guidelines that stipulated the optimal quantity of sugar per 100g of a food product.[30] The major strategies suggested to programme partners were a reduction of overall sugar per 100g, a reduction in portion size, and/or reorienting customers towards low or zero sugar options (Public Health England, 2019[173]). Engaged stakeholders include manufacturers, retailers, and trade associates (Public Health England, 2019[174]).

The sugar reduction programme operates in tandem with a second programme targeting overall calorie intake. The latter is also working with and challenging the food industry to reduce the amount of calories in their products, in this case by 20% by 2024 (Public Health England, 2018[175]; Public Health England, 2018[176]). This is complemented by informational campaigns, i.e. the PHE's OneYou campaign which aims to make adults become more aware of the number of calories they consume on a daily basis and PHE's Change4Life campaign that provides online tools such as recipes, meal-time suggestions for parents to reduce their children's intake of sugary snacks and drinks replacing processed snacks with healthier alternatives.[31]

A recent modelling study found that meeting the targets of the sugar reduction programme would result in a gain of around 52 000 quality-adjusted life years and GBP 286 million in healthcare savings over a ten-year period (Amies-Cull, Briggs and Scarborough, 2019[177]). In support of this, recent work based on the OECD SPHeP-NCDs model indicated that a 20% reduction in the calorie content of energy-dense foods (across 42 countries included in the analysis) could avoid 1.1 million cases of NCDs and save

USD (PPP) 13.2 billion in healthcare expenditures per year (OECD, 2019[27]). PHE has assessed progress in the sugar reduction programme, and found that between 2015 and 2018 there was an overall reduction of 2.9% in sugar intake per 100g of food products, with different rates of progress by category of sugary food product (Public Health England, 2019[173]).[32] More assessments will be required to determine if the 2020 targets have been met, although the most recent available evidence indicates that in 2018 it remained far short of the targeted 20% reduction by 2020. Unlike the trans fat bans implemented in Canada and the United States, UK efforts do not involve binding laws but rely on the voluntary participation of stakeholders (falling in the second track of the four-track policy approach).[33]

Marketing regulation and labelling schemes for processed foods

Marketing of energy-dense and nutrient-poor processed food products, particularly marketing directed towards children, can shape preferences and contribute to poor dietary patterns. Alternatively, the implementation of labelling schemes can be used to communicate the various attributes of processed food products to consumers, helping to promote food choices for improved health or environment outcomes. An overview of different front-of-pack labelling schemes used in OECD countries is found in Giner and Brooks (2019[3]). This section discusses examples of marketing and labelling schemes applied to processed foods in selected OECD countries.[34]

Marketing and labelling laws in Chile

Chile has one of the highest prevalence of obesity and overweight of any OECD country: in 2016, 39.8% of its population was overweight and 34.4% were obese (OECD, 2019[178]). To address this situation, Chile implemented a set of laws between 2012 and 2015 to limit the marketing (especially towards children) of foods high in sugar, sodium, calories or saturated fats, and require these food products to present warnings indicating they contain high levels of these ingredients.[35] Warning labels ("high in sugar"; "high in sodium"; "high in saturated fats"; or "high in calories") are included on foods which surpass a certain threshold of sugar, sodium, or saturated fats. Any foods exceeding the deemed threshold quantity level of these nutritional values may not be advertised in nurseries, and elementary and secondary schools, nor in general to minors under the age of 14 years, and such foods may not be distributed for free (e.g through "gifts, contests, games, or other items that attract children"). Marketing of these products is restricted to the hours of 22:00 and 6:00 as long as the marketing does not target children.

These laws have met with challenges and push-back from the food industry (World Trade Institute, 2017[179]; FAO and PAHO, 2017[180]). The food industry had concerns regarding loss of profit, violation of property rights and freedom of speech, the inability to indicate warnings based on serving size rather than the mandated 100g/ml size, and the inability to choose the warning label for their products. A recent assessment of these regulations found a significant decrease – but not elimination – in children's exposure to televised advertising (e.g. the use of cartoon characters) of products high in sugar, sodium, saturated fats, and calories (Dillman Carpentier et al., 2019[181]). Further monitoring and evaluation will be important to ensure compliance by the private sector and to understand the long-term health impacts of these regulations on the population in general.

The Nutri-Score system in France

In March 2017, the French government adopted the Nutri-Score system as a new labelling practice in France (Giner and Brooks, 2019[3]) The basic idea behind Nutri-Score is a simplification – though not a replacement, since both systems now coexist – of existing labelling practices showing the nutritional values of food products. The system assigns a nutritional value (from a score of A for highest nutritional value to an E for relatively lower nutritional value) per 100g of a food product based on an addition of desirable nutrients, and a subtraction from the score based on the presence of harmful ones (Santé Publique France, 2020[182]). The system applies to all beverages and processed foods (with the exception of alcoholic beverages, coffee, tea, and herbs).

The basic purpose of the Nutri-Score label is to allow consumers to quickly and easily gain information on the product from a single aggregated score; a scoring system which can also be helpful to researchers as a tool to disaggregate the broad category of "processed foods". For example, Nutri-Score was used in a recent analysis of adolescent and children's exposure to food advertisements, which found that television advertisements for Nutri-Score D and E foods together represented more than half of food advertising seen by children and adolescents, respectively (Santé Publique France, 2020[183]).

Belgium and Spain have since adopted the Nutri-Score label as well (in 2018). Several other European countries have announced their plans to adopt the Nutri-Score label. Mandatory front of pack labelling in the EU by the end of 2022 is being proposed by the European Commission (European Commission, 2020[184]).[36] The Nutri-Score programme remains optional (track two of the four-track policy approach), although a growing number of companies are adopting it. Companies such as Danone, Auchan, and Fleury-Michon are major participants, with some 500 brands worldwide applying the labelling system as of September 2020.[37]

Fiscal policies

The use of fiscal measures is the fourth of the four-track policy approach (i.e. excise or sales taxes), such that prices for various processed food products more closely reflect their social cost. An example is the soft drinks industry levy implemented in April 2018 in the United Kingdom (Scarborough et al., 2020[185]). In order to address well-established negative health outcomes associated with high intake levels of sugar, a tax is now applied to UK manufacturers and importers for beverages that contain more than the threshold of 5g of sugar per 100ml. Importantly, the implementation of taxes on food or beverage items that are potentially unhealthy, such as those high in sodium, free sugars, or fats, can incentivise reformulation (Giner and Brooks, 2019[3]), and a recent assessment suggests that reformulation for reduced sugar content was one of the outcomes of the soft drinks industry levy in the United Kingdom (Scarborough et al., 2020[185]).

Newspapers and other media can also play an important role in influencing public reaction to and acceptance of health policies. A study analysing newsprint articles from prominent UK national newspapers between April 2015 and November 2016 suggest that media covering the health effects of sugar and sugar-sweetened beverage (SSB) consumption, the industry's role in promoting and enabling sugar consumption, and the need for government intervention helped to open a policy window for the development of fiscal approaches that sought to improve health outcomes by reducing sugar consumption (Buckton et al., 2017[186]).

Other fiscal policy approaches targeting energy-dense and nutrient-poor food have been imposed and subsequently revoked. For example, Denmark's tax on saturated fat, a world first, was implemented in 2011 but was abolished a year after its introduction in part due to the sustained and intensive pressure exerted by food industry associations (Bødker et al., 2015[187]).

6.6. Main challenges to more coherent policies

Developing coherent policies for the processed food sector that take into account potential trade-offs and synergies across the triple challenge domains requires co-operation and co-ordination amongst policy makers, scientific experts, and food and beverage manufacturers. However, these communities do not always relate to one another in a manner optimal to delivering coherent policies that are in the public interest. Focusing on the roles of each community, the following section discusses the key challenges to implementing coherent policies that are relevant to the processed food sector.

Data scarcity

The problem of insufficient data pertaining to the consumption and characteristics of processed foods is a major challenge in developing coherent policies. Funding and budget constraints are the usual underlying causes (Giner and Brooks, 2019[3]). In particular, the laboratory tests that are necessary to obtain detailed nutrient composition data are generally very costly. Incomplete and infrequently updated food composition data makes it difficult to monitor the evolution and composition of product- and brand-specific packaged food (Ng and Popkin, 2012[159]). Inconsistencies in product classifications prevent matching food products across different food information sources (e.g. matching products across food composition and food purchasing and acquisition databases) (Giner and Brooks, 2019[3]). Existing food information databases typically do not contain data on the product- and brand-specific sustainability performance of processed food items. Additionally, there are little data available on the composition of foods consumed away from home.

For these reasons, it is difficult to estimate the true nutrient intake levels and, more broadly, evaluate the impact of policy interventions aimed at addressing processed food sector-related objectives across the triple challenges. Policies to improve the characteristics of processed food consumed away from home may be especially important as its share of the food budget has increased over the past few decades, and recent research indicates that meals from full-service and fast-food restaurants are largely of low nutritional quality (USDA ERS, 2018[188]; Liu et al., 2020[189]). More granular data are also needed to better understand processed food consumption patterns across different socio-economic strata in order to allow for improved policy targeting (Placzek, 2021[190]). The co-operation of the private sector in sharing their data with policy makers and researchers is thus important.

Co-ordination across different policy-making communities

Co-ordination across different policy communities at the national level may pose a challenge to the development of coherent policies, as agricultural, environmental, health, economic, trade, and competition policy all touch in some way the processed food sector. Furthermore, the prominence of processed food products in international trade (and the role of trade in providing inputs for further processing), as well as the rise of transnational and multinational food and beverage corporations, necessitate co-ordination at an international level. For example, international co-ordination may be important to minimize potential unnecessary impediments to trade associated with inconsistencies in front-of-pack labelling schemes for packaged foods (Giner and Brooks, 2019[3]; Thow et al., 2017[191]). Such concerns give increasing importance to international standard-setting bodies such as the Codex Alimentarius that promote the harmonisation of requirements and approaches.[38]

Lack of trust and resistance to measures that restrict choice

A lack of trust on the part of consumers can undermine efforts to achieve objectives across the triple challenge with respect to the processed food sector. Erosion of consumer trust can stem from a general lack of coherence in public messaging. For example, marketing or informational campaigns by food industry actors with vested interests (e.g. the marketing of energy-dense and nutrient-poor food products, “greenwashing”[39] of food products) can conflict with and/or drown-out scientific evidence from experts (Mozaffarian and Forouhi, 2018[192])[40]. Private interest groups, civil society and even the scientists themselves may also undertake efforts to cast doubt on the integrity of scientific evidence (Nestle, 2015[193]). As such, confusion and distrust amongst consumers can stem from the difficulty in distinguishing between “facts” and private interests. Further distrust may arise with the evolution of food and nutrition science (which prompts shifts in dietary recommendations), uncertainties and lack of consensus on certain topics, and time-lags between the generation and implementation of new knowledge, all of which can be perceived as inconsistencies in the scientific evidence base on food and nutrition (Mozaffarian, Rosenberg and Uauy, 2018[194]; Mozaffarian and Forouhi, 2018[192]). To illustrate the case of the time-lag, Mozaffarian and Forouhi (2018[192]) provide the example of low fat food options, which remain an industry focus, regardless of new evidence indicating that total fat intake is not as important to diet quality as previously suspected: more important are the intake levels of specific types of fats.

Even when the evidence base on certain foods and nutrition is firmly established and generally trusted by the public, related policy interventions that place regulatory burdens on businesses or interfere with the range of choices available to consumers – measures that can be perceived as "paternalistic – can face resistance (Reeve and Magnusson, 2015[195]; Hanock, Barnes and Rice, 2017[196]; Véliz et al., 2019[197]). For example, the ban on the sale of large sugary beverages proposed in 2012 in New York City was met with widespread concern regarding compromised individual freedom and autonomy, and the ban was ultimately repealed (Véliz et al., 2019[197]). Another example is when the restaurant industry sued the city of New York in response to menu-labelling requirements in 2008 (Brownell and Warner, 2009[198]). At the same time, the threat of binding regulations can incite a range of responses from corporations that do not wish to have their activities restricted, including lobbying (see below). Such responses by civil society and private actors have led to the preferential use of voluntary measures over direct restrictions and bans, despite concerns with respect to their efficacy (Brownell, 2012[199]; Scott, Hawkins and Knai, 2017[200]).

Corporate political activity of food and beverage companies

Stakeholder consultation is a critical part of policy development, and formal consultations should promote fair and transparent participation in policy-making. Interest groups can use a range of other means to influence policy processes, such as industry-funded scientific research, and industry funding of organisations and non-profit groups to shape news and media coverage. These new approaches often lack the transparency that comes from traditional lobbying registers or disclosure requirements. Such "corporate political activity" (CPA) (Baysinger, 1984[201]) exists in many industries, including in the processed food sector.

By themselves, these activities are not necessarily harmful and can even play an important role in providing policy makers with useful information on the potential effects of proposed measures. But as in other sectors, the economic interests pursued by food and beverage companies (e.g. the pursuit of earnings growth, maximising value for shareholders) are not necessarily aligned with public interests, for example when public policies to improve environmental or health outcomes would reduce sales or profits for some firms.[41] A key task of policy making therefore consists in finding ways to balance the diversity of interests and avoid both over-representation or under-representation (or even exclusion) of specific interests. Policy makers need to avoid a situation where decisions reflect the interests of a narrow interest group at the expense of the broader interests of society, a situation referred to as "policy capture" (OECD, 2017[202]).[42]

Research from Mialon, Swinburn and Sacks (2015[203]) noted there is limited monitoring of CPA in health-related food areas and proposed an approach at the country level, building on a taxonomy for the tobacco industry CPA previously proposed by Savell, Gilmore and Fooks (2014[204]). The proposed framework for the classification of food industry CPA consists of six types of activity: information and messaging; financial incentive; constituency building; legal; policy substitution; and opposition, fragmentation and destabilisation.[43]

Making use of this framework and the information collected from the public domain, parallel studies were recently conducted in France analysing CPA by actors in the dairy industry (including Danone, Lactalis and the Centre National Interprofessionnel de l'Economie Laitière) (Mialon and Mialon, 2017[205]) and other major actors in the food industry (including Association Nationale des Industries Agroalimentaires/National Association of Agribusiness Industries, Coca-Cola, McDonald's, Nestlé, and Carrefour) (Mialon and Mialon, 2018[206]). Prominent practices identified included "information and messaging" (e.g. framing the debate on diet- and public health-related issues, shaping the evidence base on diet- and public health-related issues, promoting deregulation), "constituency building" (e.g. seeking involvement in the community), and "policy substitution" (e.g. developing and promoting alternatives to policies). Similarly, this framework was applied to food industry actors in Australia (including the Australian Food and Grocery Council, Coca Cola, McDonald's, Nestle, and Woolworths), and common practices identified included "information and messaging" and "constituency building" (Mialon et al., 2016[207]). The prominence of these practices in particular was supported by a second study that involved interviews with former policy makers, public health advocates, and academics who had interacted with the food industry in Australia (Mialon et al., 2017[208]). Based on such findings, some have argued that industry should be excluded from the development phase of health policies (Donovan, Anwar McHenry and Vines, 2014[209]).

However, the processed food sector can be a valuable source of information, practical knowledge and technical expertise to inform the development and implementation of workable policies. For example, public officials may need to interact with industry to gain access to data relevant to certain public decisions, such as information on specific technologies, consumer research, and other unique evidence sources (OECD, 2017[202]). Engaging with industry stakeholders early in the policy development process can be critical to avoid unintended consequences.

Yet such consultations create opportunities for industry actors to provide information that favours private interests, potentially at the expense of the public good (Helm, 2010[210]; OECD, 2017[202]). This tension is illustrated in the recommendations of the 2018 Australian Obesity Report, addressing the Australian Health Star Rating (HSR) system (a front-of-pack labelling system to rate packaged foods based on their respective nutrient profiles) (Select Committee into the Obesity Epidemic in Australia, 2018[211]).[44] Among the listed recommendations is the following: "Representatives of the food and beverage industry sectors may be consulted for technical advice but no longer sit on the HSR Calculator Technical Advisory Group". This recommendation recognises the potential need for technical information from industry, but also the potential for capture when industry actors are included in the development of programmes and policies.

The complexity of interacting with the processed food sector while preventing policy capture is evident in the case of lobbying, one of the sub-categories falling under the "information and messaging" group in the food industry CPA classification framework noted above. Lobbying, "the oral or written communication with a public official to influence legislation, policy or administrative decisions" (OECD, 2010[212]), is a legitimate practice for companies to share their needs and evidence about policy problems and how to address them. It can also be a valuable means to provide policy makers with information on which to base their decisions (OECD, 2017[202]). However, there is the risk that lobbying will result in powerful interest groups having undue influence in public decision-making, and transparency and integrity are needed to manage this risk (OECD, 2014[213]).

To enhance such transparency governments can require disclosures by lobbyists, including their employer's name and name of clients, and whether the lobbyist is a former public official, receives any government funding or contributes to any political campaigns.[45] Thirteen OECD countries have mandatory lobbying registers in place. Using this information, some databases have emerged that monitor lobbying activities and allow for their subsequent scrutiny by the public. An example is the publicly available database maintained by the Centre for Responsive Politics in the United States.[46] Information contained in this database indicates that in 2019 the food processing and sales industry in the United States had lobbying expenditures of USD 24.2 million, with the top five firms consisting of PepsiCo, Grocery Manufacturers Assn, WH Group, Tyson Foods, and Nestlé. Additionally, some 68% of lobbyists in the food processing and sales industry were categorised as "revolvers", which here refers to the concept of the "political revolving door" in which former public officials hold new positions in the industries that they previously oversaw (a practice falling under the "constituency building" category in the CPA framework noted above).

Similarly, consultations with stakeholders during policy development can be documented and made publically available. This was the case with the open consultation on Canada's Food Guide (i.e. the proposed recommendations for Canada's 2019 national dietary guidelines), where feedback from over 6 000 contributors, including 98 self-identified contributors from the food and beverage industry, was collected and synthesised into a publically-available report (Government of Canada, 2018[214]). This synthesis report indicates, for example, that many contributors from the food and beverage industry in Canada disagreed about the proposed recommendation to shift away from animal proteins. They also disagreed on the focus to reduce saturated fat consumption, were concerned that food taste and general food preferences were not being taken into account, and felt the recommendations should be based on food as a whole rather than their specific nutrients.

Corporate political activity can also affect the relationship between the food and beverage industry and the scientific research community, which in turn can impact public decisions. In particular, the scientific evidence base on the impacts of various food products on health can be shaped through industry funding of food and nutrition research, another activity that falls under the CPA category of "information and messaging" (Aveyard et al., 2016[215]; Mozaffarian, 2017[216]; Mozaffarian et al., 2018[217]; Mozaffarian and Forouhi, 2018[192]; Nestle, 2016[218]; Kearns, Schmidt and Glantz, 2016[219]; Nestle, 2016[220]; Lesser et al., 2007[221]; Chartres, Fabbri and Bero, 2016[222]; Nestle, 2015[193]). For instance, bias favourable to industry has been noted in the published conclusions of industry-funded research and reviews examining the association between sugar-sweetened beverage consumption, and weight gain, obesity and diabetes (Schillinger et al., 2016[223]; Bes-Rastrollo et al., 2013[224]). Similarly, bias has been identified in industry-funded reviews assessing the link between artificially sweetened beverage intake and weight outcomes (Mandrioli, Kearns and Bero, 2016[225]). Industry funding can enable important food and nutrition research and innovations (particularly where public funds are limited), but the establishment of clear governing principles is needed to manage the relationship between the food and beverage industry and the research community in a way that minimises the production and dissemination of biased information and safeguards public interest. Importantly, private sources of research funding are not necessarily problematic: the integrity of scientific evidence, rather than concern over the source of funding should be central in the establishment of such governing principles.

6.7. Conclusion

Policies targeting the processed food sector have an important role to play in addressing objectives across the triple challenge dimensions. Processed foods include a wide range of food products with differing health, environmental, and social implications. Processing techniques, such as preservation practices and fortification, have been important for improving food security and working towards various public health objectives. At the same time, there are well established associations between excessive intake of energy-dense and nutrient-poor processed foods and an increased risk of developing conditions of overweight, obesity, specific forms of cancer and other NCDs. Food processing accounts for an important share of income generation and employment in OECD, emerging, and less developed countries, including through participation in international trade and GVCs. Environmental impacts vary across different processed food products, and the processed food sector can influence the sustainability of diets through improving energy efficiency in processing, requiring stricter environmental standards of suppliers and conveying information on environmental sustainability performance to downstream consumers.

To date, policies targeting the processed food sector have largely focused on improving health outcomes. While further research is needed to better understand the impacts of these policies, existing evidence indicates that demand-side public interventions and voluntary measures targeting the processed food sector (tracks one and two of the four-track policy approach) have limited efficacy on their own. Mandatory measures and fiscal policies (tracks three and four of the four-track policy approach) may be more promising for achieving triple challenge objectives, particularly if they are able to effectively navigate and minimize potential resistance both from industry and the public. Strategies to achieve this could include transparent engagement with industry stakeholders during policy development (especially during early stages of policy development), protecting the integrity of scientific evidence, and strengthening the public's trust in public officials and scientific experts.

When developing policies in any of the four tracks, consideration should be given to the potential negative impacts that regulatory burdens can have on industry innovation and initiatives that aim to support nutritious, sustainable, and socially responsible food systems. Addressing data scarcity pertaining to the health, environmental, and social attributes of brand- and product-specific processed food items will also be important to designing policy interventions and anticipating potential interactions that could occur across triple challenge dimensions. Overcoming challenges to the design and implementation of coherent policies will require improved co-ordination amongst policy makers, scientific experts, and industry.

References

Abarca-Gómez, L. et al. (2017), "Worldwide trends in body-mass index, underweight, overweight, and obesity from 1975 to 2016: a pooled analysis of 2416 population-based measurement studies in 128·9 million children, adolescents, and adults", *The Lancet*, Vol. 390/10113, pp. 2627-2642, http://dx.doi.org/10.1016/s0140-6736(17)32129-3. [26]

AdAge (2017), *World's Largest Advertisers: Spending is Growing (and Surging in China)*, https://adage.com/article/cmo-strategy/world-s-largest-advertisers-2017/311484 (accessed on 18 May 2020). [72]

Afshin, A. et al. (2019), "Health effects of dietary risks in 195 countries, 1990–2017: a systematic analysis for the Global Burden of Disease Study 2017", *The Lancet*, Vol. 393/10184, pp. 1958-1972, http://dx.doi.org/10.1016/s0140-6736(19)30041-8. [1]

Aiking, H. and J. de Boer (2018), "The next protein transition", *Trends in Food Science & Technology*, http://dx.doi.org/10.1016/j.tifs.2018.07.008. [120]

Alexander, P. et al. (2017), "Could consumption of insects, cultured meat or imitation meat reduce global agricultural land use?", *Global Food Security*, Vol. 15, pp. 22-32, http://dx.doi.org/10.1016/j.gfs.2017.04.001. [125]

Amies-Cull, B., A. Briggs and P. Scarborough (2019), "Estimating the potential impact of the UK government's sugar reduction programme on child and adult health: modelling study", *BMJ*, p. l1417, http://dx.doi.org/10.1136/bmj.l1417. [177]

Aveyard, P. et al. (2016), "Should we welcome food industry funding of public health research?", *BMJ*, p. i2161, http://dx.doi.org/10.1136/bmj.i2161. [215]

Baker, P. and S. Friel (2016), "Food systems transformations, ultra-processed food markets and the nutrition transition in Asia", *Globalization and Health*, Vol. 12/1, http://dx.doi.org/10.1186/s12992-016-0223-3. [16]

Baragwanath, T. (2021), *Digital opportunities for demand-side policies to improve consumer health and the sustainability of food systems*. [129]

Baraldi, L. et al. (2018), "Consumption of ultra-processed foods and associated sociodemographic factors in the USA between 2007 and 2012: evidence from a nationally representative cross-sectional study", *BMJ Open*, Vol. 8/3, p. e020574, http://dx.doi.org/10.1136/bmjopen-2017-020574. [21]

Barrett, C., M. Carter and C. Timmer (2010), "A Century-Long Perspective on Agricultural Development", *American Journal of Agricultural Economics*, Vol. 92/2, pp. 447-468, http://dx.doi.org/10.1093/ajae/aaq005. [87]

Basu, S. (ed.) (2018), "Estimating the health and economic effects of the proposed US Food and Drug Administration voluntary sodium reformulation: Microsimulation cost-effectiveness analysis", *PLOS Medicine*, Vol. 15/4, p. e1002551, http://dx.doi.org/10.1371/journal.pmed.1002551. [154]

Baysinger, B. (1984), *Domain Maintenance as an Objective of Business Political Activity: An Expanded Typology*, Academy of Management, pp. 248-258, https://www.jstor.org/stable/pdf/258438.pdf. [201]

Biban, B. and C. Lichiardopol (2017), "Iodine Deficiency, Still a Global Problem?", *Curr Health Sci J*, Vol. 42/2, pp. 103-111, http://dx.doi.org/10.12865/CHSJ.43.02.01. [55]

Bientema, N. et al. (2012), *ASTI Global Assessment of Agricultural R&D Spending*, International Food Policy Research Institute, Washington, DC, http://ebrary.ifpri.org/utils/getfile/collection/p15738coll2/id/127224/filename/127435.pdf. [84]

Blackstone, N. et al. (2018), "Linking sustainability to the healthy eating patterns of the Dietary Guidelines for Americans: a modelling study", *The Lancet Planetary Health*, Vol. 2/8, pp. e344-e352, http://dx.doi.org/10.1016/s2542-5196(18)30167-0. [109]

Bleich, S. et al. (2008), "Why Is the Developed World Obese?", *Annual Review of Public Health*, Vol. 29/1, pp. 273-295, http://dx.doi.org/10.1146/annurev.publhealth.29.020907.090954. [227]

Bødker, M. et al. (2015), "The rise and fall of the world's first fat tax", *Health Policy*, Vol. 119/6, pp. 737-742, http://dx.doi.org/10.1016/j.healthpol.2015.03.003. [187]

Boswell, R. and H. Kober (2015), "Food cue reactivity and craving predict eating and weight gain: a meta-analytic review", *Obesity Reviews*, Vol. 17/2, pp. 159-177, http://dx.doi.org/10.1111/obr.12354. [79]

Bouis, H. and A. Saltzman (2017), "Improving nutrition through biofortification: A review of evidence from HarvestPlus, 2003 through 2016", *Global Food Security*, Vol. 12, pp. 49-58, http://dx.doi.org/10.1016/j.gfs.2017.01.009. [68]

Boyland, E. et al. (2016), "Advertising as a cue to consume: a systematic review and meta-analysis of the effects of acute exposure to unhealthy food and nonalcoholic beverage advertising on intake in children and adults", *American Journal of Clinical Nutrition*, Vol. 103/2, pp. 519-533, http://dx.doi.org/10.3945/ajcn.115.120022. [77]

Brooks, J. (ed.) (2012), *Agricultural Policies for Poverty Reduction*, OECD Publishing, Paris, https://dx.doi.org/10.1787/9789264112902-en. [88]

Brownell, K. (2012), "Thinking Forward: The Quicksand of Appeasing the Food Industry", *PLoS Medicine*, Vol. 9/7, p. e1001254, http://dx.doi.org/10.1371/journal.pmed.1001254. [199]

Brownell, K. and K. Warner (2009), "The Perils of Ignoring History: Big Tobacco Played Dirty and Millions Died. How Similar Is Big Food?", *Milbank Quarterly*, Vol. 87/1, pp. 259-294, http://dx.doi.org/10.1111/j.1468-0009.2009.00555.x. [198]

Bruins, M. et al. (2015), "A Modelling Approach to Estimate the Impact of Sodium Reduction in Soups on Cardiovascular Health in the Netherlands", *Nutrients*, Vol. 7/9, pp. 8010-8019, http://dx.doi.org/10.3390/nu7095375. [156]

Buckton, C. et al. (2017), "Media representations of sugar and sugar-sweetened beverage consumption in UK newspapers: implications for public health policy", *The Lancet*, Vol. 390, p. S27, http://dx.doi.org/10.1016/s0140-6736(17)32962-8. [186]

Burgoine, T. et al. (2014), "Associations between exposure to takeaway food outlets, takeaway food consumption, and body weight in Cambridgeshire, UK: population based, cross sectional study", *BMJ*, Vol. 348/mar13 5, pp. g1464-g1464, http://dx.doi.org/10.1136/bmj.g1464. [53]

Cairns, G. et al. (2013), "Systematic reviews of the evidence on the nature, extent and effects of food marketing to children. A retrospective summary", *Appetite*, Vol. 62, pp. 209-215, http://dx.doi.org/10.1016/j.appet.2012.04.017. [74]

Cardwell, G. et al. (2018), "A Review of Mushrooms as a Potential Source of Dietary Vitamin D", *Nutrients*, Vol. 10/10, p. 1498, http://dx.doi.org/10.3390/nu10101498. [12]

Cediel, G. et al. (2017), "Ultra-processed foods and added sugars in the Chilean diet (2010)", *Public Health Nutrition*, Vol. 21/1, pp. 125-133, http://dx.doi.org/10.1017/s1368980017001161. [22]

Charlton, K. and S. Skeaff (2011), "Iodine fortification", *Current Opinion in Clinical Nutrition and Metabolic Care*, Vol. 14/6, pp. 618-624, http://dx.doi.org/10.1097/mco.0b013e32834b2b30. [56]

Chartres, N., A. Fabbri and L. Bero (2016), "Association of Industry Sponsorship With Outcomes of Nutrition Studies", *JAMA Internal Medicine*, Vol. 176/12, p. 1769, http://dx.doi.org/10.1001/jamainternmed.2016.6721. [222]

Chenarides, L. and E. Jaenicke (2018), "Documenting the Link Between Poor Food Access and Less Healthy Product Assortment Across the U.S.", *Applied Economic Perspectives and Policy*, Vol. 41/3, pp. 434-474, http://dx.doi.org/10.1093/aepp/ppy018. [45]

Chen, B. et al. (2011), "Multi-Country analysis of palm oil consumption and cardiovascular disease mortality for countries at different stages of economic development: 1980-1997", *Globalization and Health*, Vol. 7/1, p. 45, http://dx.doi.org/10.1186/1744-8603-7-45. [169]

Chowdhury, J. et al. (2018), "Reducing industrial energy demand in the UK: A review of energy efficiency technologies and energy saving potential in selected sectors", *Renewable and Sustainable Energy Reviews*, Vol. 94, pp. 1153-1178, http://dx.doi.org/10.1016/j.rser.2018.06.040. [106]

Clark, M. et al. (2019), "Multiple health and environmental impacts of foods", *Proceedings of the National Academy of Sciences*, Vol. 116/46, pp. 23357-23362, http://dx.doi.org/10.1073/pnas.1906908116. [117]

Clark, M. and D. Tilman (2017), "Comparative analysis of environmental impacts of agricultural production systems, agricultural input efficiency, and food choice", *Environmental Research Letters*, Vol. 12/6, p. 064016, http://dx.doi.org/10.1088/1748-9326/aa6cd5. [107]

Codex Alimentarius Commission (1997), *Nutrition and Health Claims (CAC/GL 23-1997)*, http://www.fao.org/ag/humannutrition/32444-09f5545b8abe9a0c3baf01a4502ac36e4.pdf. [240]

Commission for Environmental Cooperation (2017), *Characterization and Management of Food Loss and Waste in North America*. [139]

Cooksey-Stowers, K., M. Schwartz and K. Brownell (2017), "Food Swamps Predict Obesity Rates Better Than Food Deserts in the United States", *International Journal of Environmental Research and Public Health*, Vol. 14/11, p. 1366, http://dx.doi.org/10.3390/ijerph14111366. [51]

Council of Canadian Academies & Expert Panel on the State of Knowledge of Food Security in Northern Canada (2014), *Aboriginal food security in Northern Canada: an assessment of the state of knowledge*. [54]

Cox, D. (ed.) (2016), "Relationship between Research Outcomes and Risk of Bias, Study Sponsorship, and Author Financial Conflicts of Interest in Reviews of the Effects of Artificially Sweetened Beverages on Weight Outcomes: A Systematic Review of Reviews", *PLOS ONE*, Vol. 11/9, p. e0162198, http://dx.doi.org/10.1371/journal.pone.0162198. [225]

Crider, K., L. Bailey and R. Berry (2011), "Folic Acid Food Fortification—Its History, Effect, Concerns, and Future Directions", *Nutrients*, Vol. 3/3, pp. 370-384, http://dx.doi.org/10.3390/nu3030370. [61]

Dahl, R. (2010), "Green Washing", *Environmental Health Perspectives*, Vol. 118/6, http://dx.doi.org/10.1289/ehp.118-a246. [238]

Day-Rubenstein, K. and K. Fuglie (2011), , Economic Research Service, United States Department of Agriculture, https://www.ers.usda.gov/webdocs/publications/44951/11777_err130_1_.pdf?v=0. [85]

de Souza Machado, A. et al. (2018), "Microplastics as an emerging threat to terrestrial ecosystems", *Global Change Biology*, Vol. 24/4, pp. 1405-1416, http://dx.doi.org/10.1111/gcb.14020. [150]

de Souza, R. et al. (2015), "Intake of saturated and trans unsaturated fatty acids and risk of all cause mortality, cardiovascular disease, and type 2 diabetes: systematic review and meta-analysis of observational studies", *BMJ*, p. h3978, http://dx.doi.org/10.1136/bmj.h3978. [38]

Derrick, G. (ed.) (2014), "How Does the Tobacco Industry Attempt to Influence Marketing Regulations? A Systematic Review", *PLoS ONE*, Vol. 9/2, p. e87389, http://dx.doi.org/10.1371/journal.pone.0087389. [204]

Dewey, C. (2018), "Artificial trans fats, widely linked to heart disease, are officially banned", *The Washington Post*, https://www.washingtonpost.com/news/wonk/wp/2018/06/18/artificial-trans-fats-widely-linked-to-heart-disease-are-officially-banned/. [166]

Dietary Guidelines Advisory Committee (2020), *Scientific Report of the 2020 Dietary Guidelines Advisory Committee: Advisory Report to the Secretary of Agriculture and the Secretary of Health and Human Services. U.S. Department of Agriculture, Agricultural Research Service, Washington, DC*, https://www.dietaryguidelines.gov/sites/default/files/2020-07/ScientificReport_of_the_2020DietaryGuidelinesAdvisoryCommittee_first-print.pdf. [40]

Dillman Carpentier, F. et al. (2019), "Evaluating the impact of Chile's marketing regulation of unhealthy foods and beverages: pre-school and adolescent children's changes in exposure to food advertising on television", *Public Health Nutrition*, Vol. 23/4, pp. 747-755, http://dx.doi.org/10.1017/s1368980019003355. [181]

Donovan, R., J. Anwar McHenry and A. Vines (2014), "Unity of effort requires unity of object: why industry should not be involved in formulating public health policy", *Journal of Public Affairs*, Vol. 15/4, pp. 397-403, http://dx.doi.org/10.1002/pa.1553. [209]

Dötsch-Klerk, M. et al. (2015), "Reducing salt in food; setting product-specific criteria aiming at a salt intake of 5 g per day", *European Journal of Clinical Nutrition*, Vol. 69/7, pp. 799-804, http://dx.doi.org/10.1038/ejcn.2015.5. [157]

Drewnowski, A. et al. (2014), “Energy and nutrient density of foods in relation to their carbon footprint”, *The American Journal of Clinical Nutrition*, Vol. 101/1, pp. 184-191, http://dx.doi.org/10.3945/ajcn.114.092486. [115]

Drewnowski, A. and S. Specter (2004), “Poverty and obesity: the role of energy density and energy costs”, *The American Journal of Clinical Nutrition*, Vol. 79/1, pp. 6-16, http://dx.doi.org/10.1093/ajcn/79.1.6. [48]

Dubowitz, T. et al. (2014), “Healthy food access for urban food desert residents: examination of the food environment, food purchasing practices, diet and BMI”, *Public Health Nutrition*, Vol. 18/12, pp. 2220-2230, http://dx.doi.org/10.1017/s1368980014002742. [49]

Eicher-Miller, H., V. Fulgoni and D. Keast (2012), “Contributions of Processed Foods to Dietary Intake in the US from 2003–2008: A Report of the Food and Nutrition Science Solutions Joint Task Force of the Academy of Nutrition and Dietetics, American Society for Nutrition, Institute of Food Technologists, and International Food Information Council”, *The Journal of Nutrition*, Vol. 142/11, pp. 2065S-2072S, http://dx.doi.org/10.3945/jn.112.164442. [236]

Espinoza-Orias, N. and A. Azapagic (2018), “Understanding the impact on climate change of convenience food: Carbon footprint of sandwiches”, *Sustainable Production and Consumption*, Vol. 15, pp. 1-15, http://dx.doi.org/10.1016/j.spc.2017.12.002. [133]

European Commission (2020), *Farm to Fork Strategy*, https://ec.europa.eu/food/sites/food/files/safety/docs/f2f_action-plan_2020_strategy-info_en.pdf. [184]

European Commission (2018), “A European strategy for plastics in a circular economy”, https://eur-lex.europa.eu/resource.html?uri=cellar:2df5d1d2-fac7-11e7-b8f5-01aa75ed71a1.0001.02/DOC_1&format=PDF. [151]

FAO (2020), *Food Loss and Waste Database*, http://www.fao.org/food-loss-and-food-waste/flw-data/en/. [234]

FAO (2019), *Food Loss and Food Waste*, http://www.fao.org/food-loss-and-food-waste/en/ (accessed on 19 January 2020). [137]

FAO (2019), *The State of Food and Agriculture, Moving Forward on Food Loss and Waste Reduction*, http://www.fao.org/3/ca6030en/ca6030en.pdf. [138]

FAO (2019), “The State of Food Security in the World”, http://www.fao.org/3/ca5162en/ca5162en.pdf. [2]

FAO (2011), *Global Food Losses and Food Waste - Extend, Causes and Prevention*, http://www.fao.org/3/a-i2697e.pdf. [239]

FAO (2006), *Food Security*, http://www.fao.org/fileadmin/templates/faoitaly/documents/pdf/pdf_Food_Security_Cocept_Note.pdf. [44]

FAO and PAHO (2017), *Approval of a new food act in Chile: process summary*, http://www.fao.org/documents/card/en/c/5401ba19-80dd-498a-8df7-ea26bbb5de9f/. [180]

Federici, C. et al. (2019), "The impact of food reformulation on nutrient intakes and health, a systematic review of modelling studies", *BMC Nutrition*, Vol. 5/1, http://dx.doi.org/10.1186/s40795-018-0263-6. [155]

Fiolet, T. et al. (2018), "Consumption of ultra-processed foods and cancer risk: results from NutriNet-Santé prospective cohort", *BMJ*, p. k322, http://dx.doi.org/10.1136/bmj.k322. [31]

Food and Drink Federation (2018), *Food and Drink Federation's Ambition 2025: Shaping Sustainable Value Chains Progress Report 2018*, https://www.fdf.org.uk/corporate_pubs/sustainability-progress-report-2018.pdf (accessed on 14 January 2020). [104]

FoodDrinkEurope (2019), "EU food and Drink Industry Data and Trends, 2019", https://www.fooddrinkeurope.eu/uploads/publications_documents/FoodDrinkEurope_-_Data__Trends_2019.pdf. [92]

FoodDrinkEurope (2012), *Environmental Sustainability Vision Towards 2030*, https://www.fooddrinkeurope.eu/uploads/publications_documents/temp_file_FDE_RAcondense06FINAL1.pdf. [144]

Fuglie, K. (2016), "The growing role of the private sector in agricultural research and development world-wide", *Global Food Security*, Vol. 10, pp. 29-38, http://dx.doi.org/10.1016/j.gfs.2016.07.005. [83]

Garnett, T. (2016), "Plating up solutions", *Science*, Vol. 353/6305, pp. 1202-1204, http://dx.doi.org/10.1126/science.aah4765. [114]

Geyer, R., J. Jambeck and K. Law (2017), "Production, use, and fate of all plastics ever made", *Science Advances*, Vol. 3/7, p. e1700782, http://dx.doi.org/10.1126/sciadv.1700782. [146]

Gibney, M. et al. (2017), "Ultra-processed foods in human health: a critical appraisal", *The American Journal of Clinical Nutrition*, p. ajcn160440, http://dx.doi.org/10.3945/ajcn.117.160440. [8]

Giner, C. and J. Brooks (2019), "Policies for encouraging healthier food choices", *OECD Food, Agriculture and Fisheries Papers*, No. 137, OECD Publishing, Paris, https://dx.doi.org/10.1787/11a42b51-en. [3]

Gonzalez Fischer, C. and T. Garnett (2016), "Plates, pyramids, planet. Developments in national healthy and sustainable dietary guidelines: a state of play assessment", *FAO*, http://www.fao.org/3/i5640e/I5640E.pdf. [111]

Goryakin, Y. et al. (2019), "Special focus: The health and economic impact of food reformulation", in *The Heavy Burden of Obesity: The Economics of Prevention*, OECD Publishing, Paris, https://dx.doi.org/10.1787/c031ce2c-en. [241]

Government of Canada (2018), *Canada's Food Guide Consultation - Phase 2 What We Heard Report*, https://www.canada.ca/en/services/health/publications/food-nutrition/canada-food-guide-phase2-what-we-heard.html. [214]

Graf, S. and M. Cecchini (2017), "Diet, physical activity and sedentary behaviours: Analysis of trends, inequalities and clustering in selected oecd countries", *OECD Health Working Papers*, No. 100, OECD Publishing, Paris, https://dx.doi.org/10.1787/54464f80-en. [28]

Greenville, J., K. Kawasaki and M. Jouanjean (2019), “Value Adding Pathways in Agriculture and Food Trade: The Role of GVCs and Services”, *OECD Food, Agriculture and Fisheries Papers*, No. 123, OECD Publishing, Paris, https://dx.doi.org/10.1787/bb8bb93d-en. [98]

Gruère, G. (2014), “An Analysis of the Growth in Environmental Labelling and Information Schemes”, *Journal of Consumer Policy*, Vol. 38/1, pp. 1-18, http://dx.doi.org/10.1007/s10603-014-9275-z. [131]

Gruère, G. (2013), “A Characterisation of Environmental Labelling and Information Schemes”, *OECD Environment Working Papers*, No. 62, OECD Publishing, Paris, https://dx.doi.org/10.1787/5k3z11hpdgq2-en. [130]

Grunert, K., S. Hieke and J. Wills (2014), “Sustainability labels on food products: Consumer motivation, understanding and use”, *Food Policy*, Vol. 44, pp. 177-189, http://dx.doi.org/10.1016/j.foodpol.2013.12.001. [136]

Gupta, S. et al. (2019), “Characterizing Ultra-Processed Foods by Energy Density, Nutrient Density, and Cost”, *Frontiers in Nutrition*, Vol. 6, http://dx.doi.org/10.3389/fnut.2019.00070. [229]

Hall, K. et al. (2019), “Ultra-Processed Diets Cause Excess Calorie Intake and Weight Gain: An Inpatient Randomized Controlled Trial of Ad Libitum Food Intake”, *Cell Metabolism*, Vol. 30/1, pp. 67-77.e3, http://dx.doi.org/10.1016/j.cmet.2019.05.008. [34]

Hanock, Y., A. Barnes and T. Rice (2017), *Behavioral Economics and Healthy Behaviors: Key Concepts and Current Research*, Routledge. [196]

Harris, J., J. Bargh and K. Brownell (2009), “Priming effects of television food advertising on eating behavior.”, *Health Psychology*, Vol. 28/4, pp. 404-413, http://dx.doi.org/10.1037/a0014399. [78]

Headey, D. and H. Alderman (2019), “The Relative Caloric Prices of Healthy and Unhealthy Foods Differ Systematically across Income Levels and Continents”, *The Journal of Nutrition*, Vol. 149/11, pp. 2020-2033, http://dx.doi.org/10.1093/jn/nxz158. [231]

Health Canada (2019), *Food, Nutrients and Health: Interim evidence update 2018 for health professionals and policy makers*, https://www.canada.ca/content/dam/hc-sc/documents/services/canada-food-guide/resources/evidence/food-nutrients-health-interim-evidence-update-2018/pub1-eng.pdf. [41]

Health Canada (2018), *Canadian ban on trans fats comes into force today*, https://www.canada.ca/en/health-canada/news/2018/09/canadian-ban-on-trans-fats-comes-into-force-today.html. [164]

Health Council of the Netherlands (2016), “Advisory Report Dutch Dietary Guidelines 2015”, https://www.healthcouncil.nl/documents/advisory-reports/2015/11/04/dutch-dietary-guidelines-2015. [112]

Heller, M. and G. Keoleian (2018), *Beyond Meat’s Beyond Burger Life Cycle Assessment: A detailed comparison between a plant-based and an animal-based protein source*, pp. 1-38. [122]

Helm, D. (2010), “Government failure, rent-seeking, and capture: the design of climate change policy”, *Oxford Review of Economic Policy*, Vol. 26/2, pp. 182-196, http://dx.doi.org/10.1093/oxrep/grq006. [210]

Hendriksen, M. et al. (2013), "Potential effect of salt reduction in processed foods on health", *The American Journal of Clinical Nutrition*, Vol. 99/3, pp. 446-453, http://dx.doi.org/10.3945/ajcn.113.062018. [158]

Herforth, A. et al. (2019), "A Global Review of Food-Based Dietary Guidelines", *Advances in Nutrition*, Vol. 10/4, pp. 590-605, http://dx.doi.org/10.1093/advances/nmy130. [233]

Hertrampf, E. and F. Cortes (2004), "Folic Acid Fortification of Wheat Flour: Chile", *Nutrition Reviews*, Vol. 62, pp. S44-S48, http://dx.doi.org/10.1111/j.1753-4887.2004.tb00074.x. [60]

Hu, F., B. Otis and G. McCarthy (2019), "Can Plant-Based Meat Alternatives Be Part of a Healthy and Sustainable Diet?", *JAMA*, Vol. 322/16, p. 1547, http://dx.doi.org/10.1001/jama.2019.13187. [123]

ILO (2007), *The impact of global food chains on employment in the food and drink sector*, https://www.ilo.org/wcmsp5/groups/public/---ed_dialogue/---sector/documents/meetingdocument/wcms_161663.pdf. [94]

IPCC (2019), "Climate Change and Land - An IPCC Special Report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems - Summary for Policymakers", *Intergovernmental Panel on Climate Change*, accessed on 27 January 2020, https://www.ipcc.ch/site/assets/uploads/sites/4/2019/12/02_Summary-for-Policymakers_SPM.pdf. [100]

Jääskeläinen, T. et al. (2017), "The positive impact of general vitamin D food fortification policy on vitamin D status in a representative adult Finnish population: evidence from an 11-y follow-up based on standardized 25-hydroxyvitamin D data", *The American Journal of Clinical Nutrition*, p. ajcn151415, http://dx.doi.org/10.3945/ajcn.116.151415. [67]

Jouanjean, M. (2019), "Digital Opportunities for Trade in the Agriculture and Food Sectors", *OECD Food, Agriculture and Fisheries Papers*, No. 122, OECD Publishing, Paris, https://dx.doi.org/10.1787/91c40e07-en. [128]

Julia, C. et al. (2017), "Contribution of ultra-processed foods in the diet of adults from the French NutriNet-Santé study", *Public Health Nutrition*, Vol. 21/1, pp. 27-37, http://dx.doi.org/10.1017/s1368980017001367. [24]

Kadandale, S., R. Marten and R. Smith (2018), "The palm oil industry and noncommunicable diseases", *Bulletin of the World Health Organization*, Vol. 97/2, pp. 118-128, http://dx.doi.org/10.2471/blt.18.220434. [167]

Karthik, K. et al. (2017), "Understanding the Southeast Asian haze", *Environmental Research Letters*, Vol. 12/8, p. 084018, http://dx.doi.org/10.1088/1748-9326/aa75d5. [170]

Katan, M. (ed.) (2007), "Relationship between Funding Source and Conclusion among Nutrition-Related Scientific Articles", *PLoS Medicine*, Vol. 4/1, p. e5, http://dx.doi.org/10.1371/journal.pmed.0040005. [221]

Kearns, C., L. Schmidt and S. Glantz (2016), "Sugar Industry and Coronary Heart Disease Research", *JAMA Internal Medicine*, Vol. 176/11, p. 1680, http://dx.doi.org/10.1001/jamainternmed.2016.5394. [219]

Kellogg Company (2018), *Kellogg Company 2018 Annual Report*, https://investor.kelloggs.com/Cache/1001249156.PDF?O=PDF&T=&Y=&D=&FID=1001249156&iid=4133514. [71]

Knorr, D. and H. Watzke (2019), "Food Processing at a Crossroad", *Frontiers in Nutrition*, Vol. 6, http://dx.doi.org/10.3389/fnut.2019.00085. [10]

Liu, J. et al. (2020), "Quality of Meals Consumed by US Adults at Full-Service and Fast-Food Restaurants, 2003–2016: Persistent Low Quality and Widening Disparities", *The Journal of Nutrition*, http://dx.doi.org/10.1093/jn/nxz299. [189]

López González, J. et al. (2019), "Participation and benefits of SMEs in GVCs in Southeast Asia", *OECD Trade Policy Papers*, No. 231, OECD Publishing, Paris, https://dx.doi.org/10.1787/3f5f2618-en. [99]

Macdiarmid, J., F. Douglas and J. Campbell (2016), "Eating like there's no tomorrow: Public awareness of the environmental impact of food and reluctance to eat less meat as part of a sustainable diet", *Appetite*, Vol. 96, pp. 487-493, http://dx.doi.org/10.1016/j.appet.2015.10.011. [118]

Machado, P. et al. (2019), "Ultra-processed food consumption drives excessive free sugar intake among all age groups in Australia", *European Journal of Nutrition*, http://dx.doi.org/10.1007/s00394-019-02125-y. [23]

Martínez Steele, E. et al. (2017), "The share of ultra-processed foods and the overall nutritional quality of diets in the US: evidence from a nationally representative cross-sectional study", *Population Health Metrics*, Vol. 15/1, http://dx.doi.org/10.1186/s12963-017-0119-3. [13]

Mialon, M. and J. Mialon (2018), "Analysis of corporate political activity strategies of the food industry: evidence from France", *Public Health Nutrition*, Vol. 21/18, pp. 3407-3421, http://dx.doi.org/10.1017/s1368980018001763. [206]

Mialon, M. and J. Mialon (2017), "Corporate political activity of the dairy industry in France: an analysis of publicly available information", *Public Health Nutrition*, Vol. 20/13, pp. 2432-2439, http://dx.doi.org/10.1017/s1368980017001197. [205]

Mialon, M. et al. (2017), "'Maximising shareholder value': a detailed insight into the corporate political activity of the Australian food industry", *Australian and New Zealand Journal of Public Health*, Vol. 41/2, pp. 165-171, http://dx.doi.org/10.1111/1753-6405.12639. [208]

Mialon, M. et al. (2016), "Systematic examination of publicly-available information reveals the diverse and extensive corporate political activity of the food industry in Australia", *BMC Public Health*, Vol. 16/1, http://dx.doi.org/10.1186/s12889-016-2955-7. [207]

Mialon, M., B. Swinburn and G. Sacks (2015), "A proposed approach to systematically identify and monitor the corporate political activity of the food industry with respect to public health using publicly available information", *Obesity Reviews*, Vol. 16/7, pp. 519-530, http://dx.doi.org/10.1111/obr.12289. [203]

Monteiro, C. et al. (2019), *Ultra-processed foods, diet quality, and health using the NOVA classification system. Rome, FAO.*, FAO, http://www.fao.org/3/ca5644en/ca5644en.pdf. [6]

Monteiro, C. et al. (2019), "Ultra-processed foods: what they are and how to identify them", *Public Health Nutrition*, Vol. 22/5, pp. 936-941, http://dx.doi.org/10.1017/s1368980018003762. [4]

Monteiro, C. et al. (2017), "The UN Decade of Nutrition, the NOVA food classification and the trouble with ultra-processing", *Public Health Nutrition*, Vol. 21/1, pp. 5-17, http://dx.doi.org/10.1017/s1368980017000234. [5]

Monteiro, C. et al. (2013), "Ultra-processed products are becoming dominant in the global food system", *Obesity Reviews*, Vol. 14, pp. 21-28, http://dx.doi.org/10.1111/obr.12107. [17]

Monteiro, C. et al. (2017), "Household availability of ultra-processed foods and obesity in nineteen European countries", *Public Health Nutrition*, Vol. 21/1, pp. 18-26, http://dx.doi.org/10.1017/s1368980017001379. [25]

Moodie, R. et al. (2013), "Profits and pandemics: prevention of harmful effects of tobacco, alcohol, and ultra-processed food and drink industries", *The Lancet*, Vol. 381/9867, pp. 670-679, http://dx.doi.org/10.1016/s0140-6736(12)62089-3. [80]

Mottet, A. et al. (2017), "Livestock: On our plates or eating at our table? A new analysis of the feed/food debate", *Global Food Security*, Vol. 14, pp. 1-8, http://dx.doi.org/10.1016/j.gfs.2017.01.001. [119]

Moubarac, J. (2017), *Ultra-processed foods in Canada: consumption, impact on diet quality and policy implications*, https://www.heartandstroke.ca/-/media/pdf-files/canada/media-centre/hs-report-upp-moubarac-dec-5-2017.ashx. [20]

Mozaffarian, D. (2017), "Conflict of Interest and the Role of the Food Industry in Nutrition Research", *JAMA*, Vol. 317/17, p. 1755, http://dx.doi.org/10.1001/jama.2017.3456. [216]

Mozaffarian, D. et al. (2018), "Role of government policy in nutrition—barriers to and opportunities for healthier eating", *BMJ*, p. k2426, http://dx.doi.org/10.1136/bmj.k2426. [217]

Mozaffarian, D. and N. Forouhi (2018), "Dietary guidelines and health—is nutrition science up to the task?", *BMJ*, p. k822, http://dx.doi.org/10.1136/bmj.k822. [192]

Mozaffarian, D., I. Rosenberg and R. Uauy (2018), "History of modern nutrition science—implications for current research, dietary guidelines, and food policy", *BMJ*, p. k2392, http://dx.doi.org/10.1136/bmj.k2392. [194]

Muth, M. et al. (2019), "How Much Can Product Reformulation Improve Diet Quality in Households with Children and Adolescents?", *Nutrients*, Vol. 11/3, p. 618, http://dx.doi.org/10.3390/nu11030618. [160]

Narasimha Rao, D. and N. Sachindra (2002), "Modified atmosphere and vacuum packaging of meat and poultry products", *Food Reviews International*, Vol. 18/4, pp. 263-293, http://dx.doi.org/10.1081/fri-120016206. [145]

Nestle (2017), *Annual Review 2016*, https://www.nestle.com/sites/default/files/asset-library/documents/library/documents/annual_reports/2016-annual-review-en.pdf (accessed on 18 May 2020). [73]

Nestle, M. (2016), "Corporate Funding of Food and Nutrition Research", *JAMA Internal Medicine*, Vol. 176/1, p. 13, http://dx.doi.org/10.1001/jamainternmed.2015.6667. [220]

Nestle, M. (2016), “Food Industry Funding of Nutrition Research”, *JAMA Internal Medicine*, Vol. 176/11, p. 1685, http://dx.doi.org/10.1001/jamainternmed.2016.5400. [218]

Nestle, M. (2015), *Soda Politics: Taking on Big Soda (and Winning)*, Oxford University Press. [193]

Nestle, M. (2013), *Food Politics: How the Food Industry Influences Nutrition and Health*, University of California Press, https://www.jstor.org/stable/10.1525/j.ctt7zw29z. [237]

New Zealand Government (2019), “Folic acid fortification: Increasing folic acid availability in food”, *New Zealand Food Safety*, https://www.mpi.govt.nz/dmsdocument/37233-folic-acid-fortification-increasing-folic-acid-availability-in-food-discussion-document. [64]

New Zealand Government (2018), *Voluntary Folic Acid Fortification: Monitoring and Evaluation Report*, https://www.mpi.govt.nz/dmsdocument/27121/direct. [63]

Newsome, R. et al. (2014), “Applications and Perceptions of Date Labeling of Food”, *Comprehensive Reviews in Food Science and Food Safety*, Vol. 13/4, pp. 745-769, http://dx.doi.org/10.1111/1541-4337.12086. [141]

Ng, S. and B. Popkin (2012), “Monitoring Foods and Nutrients Sold and Consumed in the United States: Dynamics and Challenges”, *Journal of the Academy of Nutrition and Dietetics*, Vol. 112/1, pp. 41-45.e4, http://dx.doi.org/10.1016/j.jada.2011.09.015. [159]

Nishida, C. and R. Uauy (2009), “WHO Scientific Update on health consequences of trans fatty acids: introduction”, *European Journal of Clinical Nutrition*, Vol. 63/S2, pp. S1-S4, http://dx.doi.org/10.1038/ejcn.2009.13. [42]

Norman, J. et al. (2018), “Sustained impact of energy-dense TV and online food advertising on children’s dietary intake: a within-subject, randomised, crossover, counter-balanced trial”, *International Journal of Behavioral Nutrition and Physical Activity*, Vol. 15/1, http://dx.doi.org/10.1186/s12966-018-0672-6. [76]

OECD (2019), *Digital Opportunities for Better Agricultural Policies*, OECD Publishing, Paris, https://dx.doi.org/10.1787/571a0812-en. [127]

OECD (2019), *Innovation, Productivity and Sustainability in Food and Agriculture: Main Findings from Country Reviews and Policy Lessons*, OECD Food and Agricultural Reviews, OECD Publishing, Paris, https://dx.doi.org/10.1787/c9c4ec1d-en. [86]

OECD (2019), *OECD Reviews of Public Health: Chile: A Healthier Tomorrow*, OECD Reviews of Public Health, OECD Publishing, Paris, https://dx.doi.org/10.1787/9789264309593-en. [178]

OECD (2019), *Taxing Energy Use 2019: Using Taxes for Climate Action*, OECD Publishing, Paris, https://dx.doi.org/10.1787/058ca239-en. [232]

OECD (2019), *Technical country notes to the OECD report the Heavy Burden of Obesity*, https://doi.org/10.1787/67450d67-en. [242]

OECD (2019), *The Heavy Burden of Obesity: The Economics of Prevention*, OECD Health Policy Studies, OECD Publishing, Paris, https://dx.doi.org/10.1787/67450d67-en. [27]

OECD (2018), “Improving plastics management: trends policy responses, and the role of international co-operation and trade”, https://www.oecd.org/environment/waste/policy-highlights-improving-plastics-management.pdf. [148]

OECD (2017), *Improving Energy Efficiency in the Agro-food Chain*, OECD Green Growth Studies, OECD Publishing, Paris, https://dx.doi.org/10.1787/9789264278530-en. [103]

OECD (2017), *Preventing Policy Capture: Integrity in Public Decision Making*, OECD Public Governance Reviews, OECD Publishing, Paris, https://dx.doi.org/10.1787/9789264065239-en. [202]

OECD (2016), "Dairy and Dairy Products", in *OECD-FAO Agricultural Outlook 2016-2025*, OECD Publishing, Paris, https://dx.doi.org/10.1787/agr_outlook-2016-11-en. [11]

OECD (2016), *Policy Perspectives - Synthesis Report: Environmental Labelling and Information Schemes*, https://www.oecd.org/env/policy-persectives-environmental-labelling-and-information-schemes.pdf. [135]

OECD (2015), *Waste Prevention: A Survey of Policies and Programmes Across the OECD*, https://one.oecd.org/document/ENV/EPOC/WPRPW(2015)13/en/pdf. [140]

OECD (2014), *Lobbyists, Governments and Public Trust, Volume 3: Implementing the OECD Principles for Transparency and Integrity in Lobbying*, OECD Publishing, Paris, https://dx.doi.org/10.1787/9789264214224-en. [213]

OECD (2010), *Recommendation of the council on principles for transparency and integrity in lobbying*, https://legalinstruments.oecd.org/public/doc/256/256.en.pdf. [212]

OECD/FAO (2016), *OECD-FAO Guidance for Responsible Agricultural Supply Chains*, OECD Publishing, Paris, https://dx.doi.org/10.1787/9789264251052-en. [102]

PAHO (2015), *Ultra-processed food and drink products in Latin America: Trends, impact on obesity, policy implications*, https://iris.paho.org/bitstream/handle/10665.2/7699/9789275118641_eng.pdf?sequence=5&isAllowed=y. [7]

Palacios, C. and L. Gonzalez (2014), "Is vitamin D deficiency a major global public health problem?", *The Journal of Steroid Biochemistry and Molecular Biology*, Vol. 144, pp. 138-145, http://dx.doi.org/10.1016/j.jsbmb.2013.11.003. [66]

Pardey, P. et al. (2015), "Long-run and Global R&D Funding Trajectories: The U.S. Farm Bill in a Changing Context", *American Journal of Agricultural Economics*, Vol. 97/5, pp. 1312-1323, http://dx.doi.org/10.1093/ajae/aav035. [82]

Pastorelli, A., P. Stacchini and A. Olivieri (2014), "Daily iodine intake and the impact of salt reduction on iodine prophylaxis in the Italian population", *European Journal of Clinical Nutrition*, Vol. 69/2, pp. 211-215, http://dx.doi.org/10.1038/ejcn.2014.206. [57]

PepsiCo (2018), *Annual Report 2018*, https://www.pepsico.com/docs/album/annual-reports/2018-annual-report.pdf?sfvrsn=35d1d2bc_2. [70]

Perekhozhuk, O. et al. (2016), "Approaches and methods for the econometric analysis of market power: A survey and empirical comparison", *Journal of Economic Surveys*, Vol. 31/1, pp. 303-325, http://dx.doi.org/10.1111/joes.12141. [95]

Pilz, S. et al. (2018), "Rationale and Plan for Vitamin D Food Fortification: A Review and Guidance Paper", *Frontiers in Endocrinology*, Vol. 9, http://dx.doi.org/10.3389/fendo.2018.00373. [65]

Placzek, O. (2021), *Socio-economic and demographic aspects of food security and nutrition, OECD Food, Agriculture and Fisheries Papers, OECD Publishing, Paris (Forthcoming)*. [190]

Ploeg, M. et al. (2009), *Access to affordable and nutritious food: Measuring and undersanding food deserts and their consequences. Report to Congress. USDA ERS*. [46]

Poore, J. and T. Nemecek (2018), "Reducing food's environmental impacts through producers and consumers", *Science*, Vol. 360/6392, pp. 987-992, http://dx.doi.org/10.1126/science.aaq0216. [101]

Popkin, B. (ed.) (2020), "Impact of the announcement and implementation of the UK Soft Drinks Industry Levy on sugar content, price, product size and number of available soft drinks in the UK, 2015-19: A controlled interrupted time series analysis", *PLOS Medicine*, Vol. 17/2, p. e1003025, http://dx.doi.org/10.1371/journal.pmed.1003025. [185]

Popkin, B. (2017), "Relationship between shifts in food system dynamics and acceleration of the global nutrition transition", *Nutrition Reviews*, Vol. 75/2, pp. 73-82, http://dx.doi.org/10.1093/nutrit/nuw064. [15]

Popkin, B. (2014), "Nutrition, agriculture and the global food system in low and middle income countries", *Food Policy*, Vol. 47, pp. 91-96, http://dx.doi.org/10.1016/j.foodpol.2014.05.001. [19]

Popkin, B. and P. Gordon-Larsen (2004), "The nutrition transition: worldwide obesity dynamics and their determinants", *International Journal of Obesity*, Vol. 28/S3, pp. S2-S9, http://dx.doi.org/10.1038/sj.ijo.0802804. [32]

Poti, J., B. Braga and B. Qin (2017), "Ultra-processed Food Intake and Obesity: What Really Matters for Health—Processing or Nutrient Content?", *Current Obesity Reports*, Vol. 6/4, pp. 420-431, http://dx.doi.org/10.1007/s13679-017-0285-4. [9]

Poti, J., E. Dunford and B. Popkin (2017), "Sodium Reduction in US Households' Packaged Food and Beverage Purchases, 2000 to 2014", *JAMA Internal Medicine*, Vol. 177/7, p. 986, http://dx.doi.org/10.1001/jamainternmed.2017.1407. [153]

Poti, J. et al. (2015), "Is the degree of food processing and convenience linked with the nutritional quality of foods purchased by US households?", *The American Journal of Clinical Nutrition*, Vol. 101/6, pp. 1251-1262, http://dx.doi.org/10.3945/ajcn.114.100925. [14]

Public Health England (2019), *Reduction and reformulation programme: Table of stakeholder engagement March 2019 to July 2019*, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/832869/Stakeholder_engagement_table_March_to_July_2019.pdf. [174]

Public Health England (2019), *Sugar reduction: report on progress between 2015 and 2018*, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/832618/Sugar_reduction_summary__of_progress_2015-2018.pdf. [173]

Public Health England (2018), *Calorie reduction: the scope and ambition for action*, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/800675/Calories_Evidence_Document.pdf. [176]

Public Health England (2018), *Obesity - the scale of the problem*, https://publichealthengland.exposure.co/sugar-reduction-programme. [172]

Public Health England (2018), *The things you need to know about calorie reduction*, https://publichealthengland.exposure.co/the-things-you-need-to-know-about-calorie-reduction. [175]

Rahkovsky, I., Y. Jo and A. Carlson (2018), *Consumers balance time and money in purchasing convenience foods*, https://www.ers.usda.gov/publications/pub-details/?pubid=89343. [226]

Ratnayake, W., M. L'Abbe and D. Mozaffarian (2008), "Nationwide product reformulations to reduce trans fatty acids in Canada: when trans fat goes out, what goes in?", *European Journal of Clinical Nutrition*, Vol. 63/6, pp. 808-811, http://dx.doi.org/10.1038/ejcn.2008.39. [168]

Ray, J. (2004), "Folic Acid Food Fortification in Canada", *Nutrition Reviews*, Vol. 62, pp. S35-S39, http://dx.doi.org/10.1111/j.1753-4887.2004.tb00072.x. [62]

Reardon, T. and C. Timmer (2012), "The Economics of the Food System Revolution", *Annual Review of Resource Economics*, Vol. 4/1, pp. 225-264, http://dx.doi.org/10.1146/annurev.resource.050708.144147. [89]

Reeve, B. and R. Magnusson (2015), "Reprint of: Food reformulation and the (neo)-liberal state: new strategies for strengthening voluntary salt reduction programs in the UK and USA", *Public Health*, Vol. 129/8, pp. 1061-1073, http://dx.doi.org/10.1016/j.puhe.2015.04.021. [195]

SACN (2019), *Saturated fats and health*, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/814995/SACN_report_on_saturated_fat_and_health.pdf. [39]

SACN (2015), *Carbohydrates and health*, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/445503/SACN_Carbohydrates_and_Health.pdf. [235]

Sadeghirad, B. et al. (2016), "Influence of unhealthy food and beverage marketing on children's dietary intake and preference: a systematic review and meta-analysis of randomized trials", *Obesity Reviews*, Vol. 17/10, pp. 945-959, http://dx.doi.org/10.1111/obr.12445. [75]

Santé Publique France (2020), *Exposition des enfants et des adolescents à la publicité pour des produits gras, sucrés, salés*, https://www.santepubliquefrance.fr/determinants-de-sante/nutrition-et-activite-physique/documents/rapport-synthese/exposition-des-enfants-et-des-adolescents-a-la-publicite-pour-des-produits-gras-sucres-sales. [183]

Santé Publique France (2020), *Nutri-Score*, https://www.santepubliquefrance.fr/determinants-de-sante/nutrition-et-activite-physique/articles/nutri-score. [182]

Schillinger, D. et al. (2016), "Do Sugar-Sweetened Beverages Cause Obesity and Diabetes? Industry and the Manufacture of Scientific Controversy", *Annals of Internal Medicine*, Vol. 165/12, p. 895, http://dx.doi.org/10.7326/l16-0534. [223]

Schmidt Rivera, X., N. Espinoza Orias and A. Azapagic (2014), "Life cycle environmental impacts of convenience food: Comparison of ready and home-made meals", *Journal of Cleaner Production*, Vol. 73, pp. 294-309, http://dx.doi.org/10.1016/j.jclepro.2014.01.008. [134]

Schnabel, L. et al. (2018), "Association Between Ultra-Processed Food Consumption and Functional Gastrointestinal Disorders: Results From the French NutriNet-Santé Cohort", *American Journal of Gastroenterology*, Vol. 113/8, pp. 1217-1228, http://dx.doi.org/10.1038/s41395-018-0137-1. [33]

Schweitzer, J., F. Petsinaris and S. Gionfra (2018), "Justifying plastics pollution - How Life Cycle Assessments are misused in food packaging policy. A study by Zero waste and Friends of the Earth v for the Rethink plastics Alliance", *Institute for European Environmental Policy*, https://ieep.eu/uploads/articles/attachments/d028bd51-4f3d-48e2-8573-72bd33697dcf/Shortcomings%20of%20LCA%20in%20food%20packaging%20policy%20-%20Unwrapped%20Packaging%20and%20Food%20Waste%20IEEP%202018.pdf?v=63690. [149]

Scott Matthews, H., C. Hendrickson and D. Matthews (2014), *Life Cycle assessment: Quantitative Approaches for Decisions that Matter*, https://www.lcatextbook.com/. [132]

Scott, C., B. Hawkins and C. Knai (2017), "Food and beverage product reformulation as a corporate political strategy", *Social Science & Medicine*, Vol. 172, pp. 37-45, http://dx.doi.org/10.1016/j.socscimed.2016.11.020. [200]

Scrinis, G. and C. Monteiro (2017), "Ultra-processed foods and the limits of product reformulation", *Public Health Nutrition*, Vol. 21/1, pp. 247-252, http://dx.doi.org/10.1017/s1368980017001392. [161]

Select Committee into the Obesity Epidemic in Australia (2018), *Final Report: Obesity Epidemic in Australia*, https://www.aph.gov.au/Parliamentary_Business/Committees/Senate/Obesity_epidemic_in_Australia/Obesity/Final_Report (accessed on March 2020). [211]

Seto, K. and N. Ramankutty (2016), "Hidden linkages between urbanization and food systems", *Science*, Vol. 352/6288, pp. 943-945, http://dx.doi.org/10.1126/science.aaf7439. [228]

Sexton, R. and T. Xia (2018), "Increasing Concentration in the Agricultural Supply Chain: Implications for Market Power and Sector Performance", *Annual Review of Resource Economics*, Vol. 10/1, pp. 229-251, http://dx.doi.org/10.1146/annurev-resource-100517-023312. [97]

Sheldon, I. (2016), "The competitiveness of agricultural product and input markets: A review and synthesis of recent research", *Journal of Agricultural and Applied Economics*, Vol. 49/1, pp. 1-44, http://dx.doi.org/10.1017/aae.2016.29. [96]

Siegel, R. (ed.) (2019), "Impact of multiple food environments on body mass index", *PLOS ONE*, Vol. 14/8, p. e0219365, http://dx.doi.org/10.1371/journal.pone.0219365. [52]

Sievert, K. et al. (2019), "Processed Foods and Nutrition Transition in the Pacific: Regional Trends, Patterns and Food System Drivers", *Nutrients*, Vol. 11/6, p. 1328, http://dx.doi.org/10.3390/nu11061328. [18]

Spiteri, M. and L. Soler (2017), "Food reformulation and nutritional quality of food consumption: an analysis based on households panel data in France", *European Journal of Clinical Nutrition*, Vol. 72/2, pp. 228-235, http://dx.doi.org/10.1038/s41430-017-0044-3. [152]

Springmann, M. et al. (2018), "Options for keeping the food system within environmental limits", *Nature*, Vol. 562/7728, pp. 519-525, http://dx.doi.org/10.1038/s41586-018-0594-0. [108]

Springmann, M. et al. (2016), "Analysis and valuation of the health and climate change cobenefits of dietary change", *Proceedings of the National Academy of Sciences*, Vol. 113/15, pp. 4146-4151, http://dx.doi.org/10.1073/pnas.1523119113. [121]

Stuckler, D. (ed.) (2013), “Financial Conflicts of Interest and Reporting Bias Regarding the Association between Sugar-Sweetened Beverages and Weight Gain: A Systematic Review of Systematic Reviews”, *PLoS Medicine*, Vol. 10/12, p. e1001578, http://dx.doi.org/10.1371/journal.pmed.1001578. [224]

Stuckler, D. and M. Nestle (2012), “Big Food, Food Systems, and Global Health”, *PLoS Medicine*, Vol. 9/6, p. e1001242, http://dx.doi.org/10.1371/journal.pmed.1001242. [81]

Swinnen, J. and M. Maertens (2007), “Globalization, privatization, and vertical coordination in food value chains in developing and transition countries”, *Agricultural Economics*, Vol. 37, pp. 89-102, http://dx.doi.org/10.1111/j.1574-0862.2007.00237.x. [93]

Tassou, S. et al. (2014), “Energy demand and reduction opportunities in the UK food chain”, *Proceedings of the Institution of Civil Engineers - Energy*, Vol. 167/3, pp. 162-170, http://dx.doi.org/10.1680/ener.14.00014. [105]

The Coca-Cola Company (2018), *Annual report pursuant to section 13 or 15(d) of the securities exchange act of 1934*, https://www.sec.gov/Archives/edgar/data/21344/000002134419000014/a2018123110-k.htm. [69]

The Global Burden of Diseases Nutrition and Chronic Diseases Expert Group (NutriCoDE) (2016), “Impact of Nonoptimal Intakes of Saturated, Polyunsaturated, and Trans Fat on Global Burdens of Coronary Heart Disease”, *Journal of the American Heart Association*, Vol. 5/1, http://dx.doi.org/10.1161/jaha.115.002891. [37]

The World Bank (2019), “Future of Food: Harnessing Digital Technologies to Improve Food System Outcomes”, https://openknowledge.worldbank.org/bitstream/handle/10986/31565/Future-of-Food-Harnessing-Digital-Technologies-to-Improve-Food-System-Outcomes.pdf?sequence=1&isAllowed=y. [126]

The World Bank (2017), *Future of Food: Shaping the Food System to Deliver Jobs*, http://documents.worldbank.org/curated/en/406511492528621198/pdf/114394-WP-PUBLIC-18-4-2017-10-56-45-ShapingtheFoodSystemtoDeliverJobs.pdf. [90]

The World Bank (2016), *The cost of fire: an economic analysis of Indonesia’s 2015 fire crisis.*, http://pubdocs.worldbank.org/en/643781465442350600/Indonesia-forest-fire-notes.pdf. [171]

Thow, A. et al. (2017), “Nutrition labelling is a trade policy issue: lessons from an analysis of specific trade concerns at the World Trade Organization”, *Health Promotion International*, p. daw109, http://dx.doi.org/10.1093/heapro/daw109. [191]

Tilman, D. and M. Clark (2014), “Global diets link environmental sustainability and human health”, *Nature*, Vol. 515/7528, pp. 518-522, http://dx.doi.org/10.1038/nature13959. [116]

US FDA (2018), *Final determination regarding partially hydrogenated oils (removing trans fats)*, https://www.fda.gov/food/food-additives-petitions/final-determination-regarding-partially-hydrogenated-oils-removing-trans-fat. [165]

USDA ERS (2018), *America’s Eating Habits: Food Away From Home*, https://www.ers.usda.gov/webdocs/publications/90228/eib-196.pdf?v=8116.5. [188]

USDA, ERS (2003), *From Supply Push to Demand Pull: Agribusiness Strategies for Today's Consumers*, https://www.ers.usda.gov/amber-waves/2003/november/from-supply-push-to-demand-pull-agribusiness-strategies-for-today-s-consumers/. [230]

Valdes, A. et al. (2018), "Role of the gut microbiota in nutrition and health", *BMJ*, p. k2179, http://dx.doi.org/10.1136/bmj.k2179. [29]

van der Weele, C. et al. (2019), "Meat alternatives: an integrative comparison", *Trends in Food Science & Technology*, Vol. 88, pp. 505-512, http://dx.doi.org/10.1016/j.tifs.2019.04.018. [124]

Véliz, C. et al. (2019), "Sugar, Taxes, & Choice", *Hastings Center Report*, Vol. 49/6, pp. 22-31, http://dx.doi.org/10.1002/hast.1067. [197]

Ver Ploeg, M. and I. Rahkovsky (2016), *Recent Evidence on the Effects of Food Store Access on Food Choice and Diet Quality*, https://www.ers.usda.gov/amber-waves/2016/may/recent-evidence-on-the-effects-of-food-store-access-on-food-choice-and-diet-quality/. [50]

Verkaik-Kloosterman, J., P. van 't Veer and M. Ocké (2010), "Reduction of salt: Will iodine intake remain adequate in The Netherlands?", *British Journal of Nutrition*, Vol. 104/11, pp. 1712-1718, http://dx.doi.org/10.1017/s0007114510002722. [58]

Vieux, F. et al. (2013), "High nutritional quality is not associated with low greenhouse gas emissions in self-selected diets of French adults", *The American Journal of Clinical Nutrition*, Vol. 97/3, pp. 569-583, http://dx.doi.org/10.3945/ajcn.112.035105. [113]

Walker, R., C. Keane and J. Burke (2010), "Disparities and access to healthy food in the United States: A review of food deserts literature", *Health & Place*, Vol. 16/5, pp. 876-884, http://dx.doi.org/10.1016/j.healthplace.2010.04.013. [47]

Wansink, B. and A. Wright (2006), ""Best if Used By?" How Freshness Dating Influences Food Acceptance", *Journal of Food Science*, Vol. 71/4, pp. S354-S357, http://dx.doi.org/10.1111/j.1750-3841.2006.00011.x. [143]

Watkins, E. et al. (2019), "Policy approaches to incentivise sustainable plastic design", *OECD Environment Working Papers*, No. 149, OECD Publishing, Paris, https://dx.doi.org/10.1787/233ac351-en. [147]

WHO (2020), *Healthy Diet*, https://www.who.int/news-room/fact-sheets/detail/healthy-diet. [35]

WHO (2019), *Countdown to 2023: WHO report on global trans fat elimination 2019*, https://www.who.int/docs/default-source/documents/replace-transfats/report-on-tfa-elimination-2019.pdf?sfvrsn=c9378613_4. [163]

WHO (2019), *Draft guidelines on saturated fatty acid and trans-fatty acid intake for adults and children*, https://extranet.who.int/dataform/upload/surveys/666752/files/Draft%20WHO%20SFA-TFA%20guidelines_04052018%20Public%20Consultation(1).pdf. [43]

WHO (2019), *REPLACE trans fat: an action package to eliminate industrially produced trans-fatty acids*, https://www.who.int/docs/default-source/replace-transfat/1-replace-framework-updated-june-2019-ke.pdf. [162]

WHO (2015), *Guideline: Sugars intake for adults and children*, https://apps.who.int/iris/bitstream/handle/10665/149782/9789241549028_eng.pdf?sequence=1&isAllowed=y. [36]

WHO and FAO (2002), *Diet, nutrition and the prevention of chronic diseases*, https://www.who.int/dietphysicalactivity/publications/trs916/download/en/. [30]

Wilkinson, J. and R. Rocha (2008), "Agri-processing and developing countries", *The World Bank, World Development Report 2008*, http://documents.worldbank.org/curated/en/965771468161642622/pdf/413800Agriproc10Developing01PUBLIC1.pdf. [91]

Willett, W. et al. (2019), "Food in the Anthropocene: the EAT–Lancet Commission on healthy diets from sustainable food systems", *The Lancet*, Vol. 393/10170, pp. 447-492, http://dx.doi.org/10.1016/s0140-6736(18)31788-4. [110]

Wilson, N. et al. (2017), "Food waste: The role of date labels, package size, and product category", *Food Quality and Preference*, Vol. 55, pp. 35-44, http://dx.doi.org/10.1016/j.foodqual.2016.08.004. [142]

World Trade Institute (2017), *Recent Changes in Food Labelling Regulations in Latin America: the Case of Chile and Peru*, https://www.wti.org/media/filer_public/3e/93/3e932c57-0f39-4f99-885e-20b5f7231748/working_paper_no_04_2017_boza_et_al.pdf. [179]

Zimmermann, M. (2011), "Iodine deficiency in industrialized countries*", *Clinical Endocrinology*, Vol. 75/3, pp. 287-288, http://dx.doi.org/10.1111/j.1365-2265.2011.04168.x. [59]

Notes

[1] This chapter uses the term "processed food" to refer broadly to any food that has undergone any transformation from its raw form. This category encompasses a broad range of food products that have been processed to varying degrees and make varying contributions to each of the triple challenge domains.

[2] See https://stat.unido.org/app/country/Emp.htm?Country=124&Group=null.

[3] In this report, data for food, beverage, and tobacco are sometimes presented in the aggregate because many food and beverage companies also engage in tobacco processing activities and disaggregated data are typically unavailable. Where available, disaggregated data are presented.

[4] See https://fortune.com/global500/2019/search/

[5] The four-track approach consists of demand side public interventions, efforts to work with industry at the supply-demand interface, firmer regulations, and fiscal measures.

[6] For examples of other classification systems, see (Poti et al., 2015[14]) and (Eicher-Miller, Fulgoni and Keast, 2012[236]).

[7] Research on diet quality is evolving. A growing body of evidence is outlining the linkages between poor diets and negative health outcomes. Based on the current body of scientific evidence pertaining to health, nutrition, and the qualities that make up healthy dietary patterns, the World Health Organisation provides recommendations for the intake of whole foods, fats, salt, and sugar in the WHO Healthy Diet Fact Sheet (WHO, 2020[35]). In addition, national-level food based dietary guidelines are available for 90 countries globally (Herforth et al., 2019[233]).

[8] Rising national incomes typically lead to a declining share of disposable income spent on food (Engel's law) and shifts towards higher caloric consumption and more diverse diets (Bennett's law). Arguably, the rise of processed foods is a similar stylised fact. Technological innovations and shifts in living and working conditions make "ready-to-consume" foods or food away from home an attractive alternative to preparing meals at home (Rahkovsky, Jo and Carlson, 2018[226]). Factors such as increasing urbanisation and a greater number of women entering the labour force have fuelled the growing demand for convenient processed/preserved food products (Bleich et al., 2008[227]; Seto and Ramankutty, 2016[228]).

[9] Many types of processed foods have evolved in order to meet emerging consumer preferences for convenience and palatability, while remaining affordable (Gupta et al., 2019[229]; USDA, ERS, 2003[230]). This is partly achieved through a heavy reliance on low-cost and energy-dense ingredients such as sugars, fats, oils, and grains (Drewnowski and Specter, 2004[48]; Headey and Alderman, 2019[231]).

[10] Spatial overviews of food access in the United States by income levels and a community's ability to access healthy food are downloadable at the USDA ERS Food Access Research Atlas and Food Environment Atlas websites. See https://www.ers.usda.gov/data-products/food-access-research-atlas/ and https://www.ers.usda.gov/data-products/food-environment-atlas/

[11] The socio-economic and demographic determinants of food choices are explored in greater detail in (Placzek, 2021[190])

[12]This dietary transition is particularly complex among Indigenous peoples in northern Canada, and can involve interactions between traditional/country food systems and market food systems, as well as various socio-economic factors. This is explored in detail in (Council of Canadian Academies & Expert Panel on the State of Knowledge of Food Security in Northern Canada, 2014[54]), and more recently in work from PROOF, an interdisciplinary research programme working to identify effective policy interventions to reduce household food insecurity in Canada, https://proof.utoronto.ca/

[13] The Codex Alimentarius Commission has established guidelines for the use of nutrition and health claims in food labelling (Codex Alimentarius Commission, 1997[240]). Many countries have national regulations for the use of nutrition and health claims.

[14] Health Canada is working on a regulatory framework for Supplemented Foods. A supplemented food is broadly defined as a pre-packaged product that is manufactured, sold or represented as a food, which contains added vitamins, minerals, amino acids, herbal or bioactive ingredients. These ingredients may perform a physiological role beyond the provision of nutritive requirements.

[15] The global estimate for value added from food and beverage manufacturing is from FAOSTAT, http://www.fao.org/faostat/en/#data/MK (accessed February 2020); Beverages include alcoholic beverage products.

[16] See UNIDO Statistical Country Briefs (ISIC rev3), https://stat.unido.org/app/country/Emp.htm?Country=124&Group=null (accessed February 2020).

[17] See https://www.ers.usda.gov/data-products/food-dollar-series/documentation/

[18] While participation in GVCs can provide domestic opportunities to transition along the value chain to the production of more "sophisticated" processed products, in some contexts just as much domestic value added can be generated via the export of a higher volume of primary agricultural products (Greenville, Kawasaki and Jouanjean, 2019[98]).

[19] Much of the energy consumed in food processing and manufacture goes towards heating and cooling procedures. Technologies such as the recirculation of air in dryers, waste recovery, and pre-cooling methods are particularly helpful for improving energy efficiency (OECD, 2017[103]).

[20] For a more detailed discussion of the poor alignment between energy taxes and the negative impacts of energy consumption, see OECD (2019[232]).

[21] Some life-cycle assessments suggest that ready-to-eat food has higher emissions relative to similar home-made products (Box 6.5).

[22] See the Mintel Global New Products Database: https://fr.mintel.com/gnpd-global-new-products-database.

[23] https://data.nal.usda.gov/dataset/usda-branded-food-products-database.

[24] https://www.oqali.fr/Base-de-donnees-Oqali.

[25] Previous FAO estimates from 2011 put total food loss and waste at one-third of global production by weight and around one-quarter by calories (FAO, 2011[239]). Given more recent advances in data and methodology, these estimates are currently being revised by FAO and the United Nations Environment Programme. Numbers cited here refer to FAO's revised estimates for food loss (FAO, 2019[138]).

[26] These data can be explored using the FAO Food Loss and Waste Database, (FAO, 2020[234]).

[27] For an overview of how policies can be used to incentivise sustainable plastic design, see (Watkins et al., 2019[147])

[28] For more examples and discussions on reformulation in terms of health and economic impacts in OECD countries, see (Goryakin et al., 2019[241]).

[29]See https://www.who.int/nutrition/topics/replace-transfat.

[30] Sugar here refers to the intake of free sugars, under the definition adopted by the Scientific Advisory Committee on Nutrition, "all monosaccharides and disaccharides added to foods by the manufacturer, cook or consumer, plus sugars naturally present in honey, syrups and unsweetened fruit juices" (SACN, 2015[235]). This definition is in line with the WHO definition (Box 6.2).

[31] See https://www.nhs.uk/change4life#5IfkYIFWdGz0hJdU.97

32 The major food product targets include breakfast cereals, yogurts, ice cream, confectionary, and cakes; although the Change4Life campaign also insists on the reduction of sugary drink intake.

33 For yearly summaries of stakeholder engagements, see https://www.gov.uk/government/publications/sugar-reduction-and-wider-reformulation-stakeholder-engagement

34 More information and comparisons across 52 countries in terms of life expectancy, health and labour market costs of different interventions, including FOP labelling and product reformulation, can be found in the technical notes to the OECD's 2019 report on obesity (OECD, 2019[27]) (OECD, 2019[242]).

35 Three laws enact these changes: Law 20.780 (a beverage tax law instituted in 2014), Law 20.606 (an advertising law instituted in 2012), and Law 20.869 (a food marketing law instituted in 2015).

36 See https://fr.openfoodfacts.org/nutriscore.

37 For a full list of participating companies, see https://world.openfoodfacts.org/label/nutriscore/brands.

38 See http://www.fao.org/fao-who-codexalimentarius/about-codex/en/; Proposed draft guidelines on front-of-pack nutrition labelling from the 2019 Codex Committee on Food Labelling are available at http://www.fao.org/fao-who-codexalimentarius/sh-proxy/en/?lnk=1&url=https%253A%252F%252Fworkspace.fao.org%252Fsites%252Fcodex%252FMeetings%252FCX-714-45%252Fdocuments%252Ffl45_06e_final.pdf.

39 Referring the practice of using misleading or fraudulent claims pertaining to the environmental performance of products (Dahl, 2010[238]).

40 Sensational news media headlines can also add to the confusion and distrust.

41 Growing evidence and awareness of the negative health effects associated with certain categories of food products and certain ingredients used in processed food products can be understood by food and beverage companies as a business risk. For example, in Coca-Cola's 2018 annual report, one of the listed risk factors was as follows, "obesity and other health related concerns may reduce demand for some of our products" (The Coca-Cola Company, 2018[69]). Likewise, potential policy measures to improve public health outcomes and also environmental outcomes can be understood by food and beverage companies as risks. For example, the list of risk factors contained in PepsiCo's 2018 annual report included "the imposition or proposed imposition of new or increased taxes aimed at our products could adversely affect our business, financial condition or results of operations", "significant additional labelling or warning requirements or limitations on the marketing or sale of our products may reduce demand for such products and could adversely affect our business, financial condition or results of operations", and "changes in laws and regulations relating to the use or disposal of plastics or other packaging of our products could continue to increase our costs, reduce demand for our products or otherwise have an adverse impact on our business, reputation, financial condition or results of operations" (PepsiCo, 2018[70]). Food and beverage companies that anticipate adverse impacts (e.g. threats to profitability) from various health (or environmental) initiatives may resist them (Nestle, 2013[237]).

42 As discussed in Chapter 3, previous OECD work provides four key recommendations to prevent policy capture: 1) levelling the playing field; 2) enforcing the right to know; 3) promoting accountability through competition authorities, regulatory agencies and supreme audit institutions; and 4) identifying and mitigating capture risk factors through appropriate organisational integrity policies (OECD, 2017[202]).

43 For a more detailed description of the types of practices falling under each of these six groups, see (Mialon, Swinburn and Sacks, 2015[203]).

44 See http://www.healthstarrating.gov.au/internet/healthstarrating/publishing.nsf/Content/About-health-stars

[45] Governments can further enable scrutiny of lobbying activities by providing timely, reliable, accessible and intelligible public disclosures of reports on those activities. Moreover, creating open and user-friendly registers can facilitate public access to data on lobbying activities.

[46] See https://www.opensecrets.org/federal-lobbying/summary (monitored by the Centre for Responsive Politics).

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