4. Food supply chains for better nutrition[17]

Agricultural products reach consumers through food supply chains. Each link in a food supply chain affects the availability, affordability, diversity and nutritional quality of foods. How foods are handled throughout a chain influences their nutritional content and prices as well as the ease with which consumers can access them. This, in turn, shapes consumer choices, dietary patterns and nutritional outcomes.

Opportunities exist at each link in the chain to deliver more diverse and nutritious foods. For example, proper household storage can preserve nutrients; food processors can use more nutritious inputs or can fortify foods during processing; logistics firms can employ nutrient-preserving techniques for storage and transport; and retailers can provide a more diverse range of foods consistently throughout the year. At every link in the chain, better technologies and management practices can preserve nutrients, reduce food losses and waste, and enhance efficiency and lower prices for nutritious foods.

This chapter reviews (i) transformations in traditional and modern food supply chains and the general impact pathways through which supply chains influence nutritional outcomes and (ii) specific opportunities to improve nutritional performance throughout the supply chain, including improving efficiency, reducing nutrient waste and losses and enhancing the nutritional quality of foods.

Transformation of food supply chains

Food supply chains are changing in complex ways, driven by economic development, urbanization and social change and facilitated in many cases by policy reforms. Modern supply chains led by large food processors, distributors and retailers are expanding rapidly in many developing countries, where they may complement rather than replace traditional supply chains. Modern supply chains exist alongside and integrate to varying degrees with traditional supply chains such as farmer/traders, wet markets, small independent stores and street vendors (Gómez and Ricketts, 2012). At the same time, traditional farmers' markets are re-emerging in many developed countries to satisfy consumer preferences for local, seasonal and artisanal products. The result is great diversity in the way food is supplied to consumers.

Supply chains differ according to the country context, the location and characteristics of producers and consumers, and the goods themselves (e.g. fresh produce, dairy products or processed goods). Some of the modern food companies are international in scope and operate global procurement and distribution activities, although many are national or regional food companies that have emerged in Africa, Asia and Latin America and the Caribbean.

The increased industrialization of the food system has been accompanied by rapid consolidation and increasing integration of the different segments of the food industry (Reardon and Timmer, 2012). This consolidation is also cross-boundary, with multinational food companies investing heavily in developing countries over the last few decades. International food companies are major investors, producers and retailers in developing countries, but international trade comprises only 10 percent of total processed food sales, meaning that 90 percent of processed foods are produced domestically (Regmi and Gehlhar, 2005).

There is a high degree of market concentration in the food manufacturing and food retail sectors globally and in many countries (Stuckler and Nestle, 2012). This has raised concerns about the power of food companies over prices and also, increasingly,

[17] This chapter is based in part on Gómez and Ricketts (2012).

over the types of product marketed, the intensity of marketing and changes in local food cultures (Monteiro and Cannon, 2012).

Traditional and modern supply chains for different foods

In the traditional food systems of most developing countries, consumers in rural and urban areas typically buy most of their food from small independent retailers. Meat, fish, fruits, vegetables and bulk grains are typically sold in "wet markets" at roadside stands and open markets, while processed goods such as pasta, rice, packaged and canned items and some meat and dairy products are sold in small shops or kiosks. Fresh produce usually comes from farms in relatively close proximity to these markets and generally reflects local and seasonal production. Packaged and processed goods may be produced nationally or imported.

Multiple links connect producers to consumers through intricate networks. Numerous traders, wholesalers, retailers and other intermediaries procure products from local markets or directly from farmers and then channel them to the next link in the chain. Traditional market systems can include large regional markets that function like distribution hubs as well as smaller, local, weekly markets with a more limited range of products. Goods ripple out from these markets to smaller retailers in both urban and rural areas (Reardon, Henson and Gulati, 2010; Reddy, Murthy and Meena, 2010; Gorton, Sauer and Supatpongkul, 2011; Ruben *et al.*, 2007).

As the food system transforms, wet markets (including those for fish and meat as well as other fresh produce) may continue to be prevalent, but larger stores with a wider range of goods may replace the smaller kiosks. Production, purchasing and processing units all tend to increase in scale. Agribusiness input suppliers, food processors and retailers drive the integration of these activities, each of which may manage its own procurement and distribution activities. Supermarket chains begin to appear, often linked to foreign investors. They bring with them new technologies, more integrated supply chains and often greater links to their own suppliers outside the country. Although supermarkets establish themselves first in the largest cities, they subsequently spread to secondary cities (Reardon and Timmer, 2012).

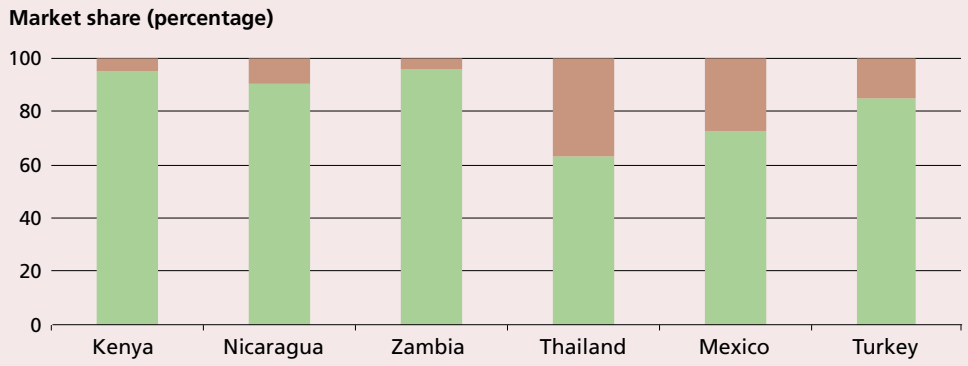
Diverse supply chains for diverse diets

Despite the growth of supermarkets, traditional food systems are still the main avenue through which people in developing countries purchase most of their food. Even in those developing countries where supermarkets emerged earliest and have penetrated most, they control only about 50–60 percent of food retail. In most developing countries, including China and India, the spread of supermarkets started later and the corresponding food retail share is below 50 percent (Reardon and Gulati, 2008). Traditional retail outlets continue to be the preferred avenue for most consumers to access fresh, unprocessed products, such as fruits and vegetables (Figure 8). In Kenya, Nicaragua and Zambia, over 90 percent of all fruits and vegetables are purchased through traditional outlets.

At the same time, sales of processed and packaged foods are growing quickly in developing countries (Figure 9), and this growth is likely to continue. Evidence indicates that even low-income consumers buy processed and packaged foods in supermarkets (Cadilhon, Moustier and Poole, 2006; Goldman, Ramaswami and Krider, 2002), but, more interestingly, much of this growth is being fuelled by modern global food manufacturers selling products through traditional outlets in both urban and rural areas (Euromonitor, 2011a). In India, for example, small independent grocers called *kirana* stores, ubiquitous in urban and rural areas, sold over 53 percent of packaged foods at the retail level in 2010. The figure for similar outlets in Brazil, called *mercadinhos*, was over 21 percent (Euromonitor, 2011a). Between 1996 and 2002, while retailing of packaged foods in high-income countries grew by only 2.5 percent in per capita terms, it grew by 28 percent in lower-middle income countries and 12 percent in low-income countries (Hawkes *et al.*, 2010).

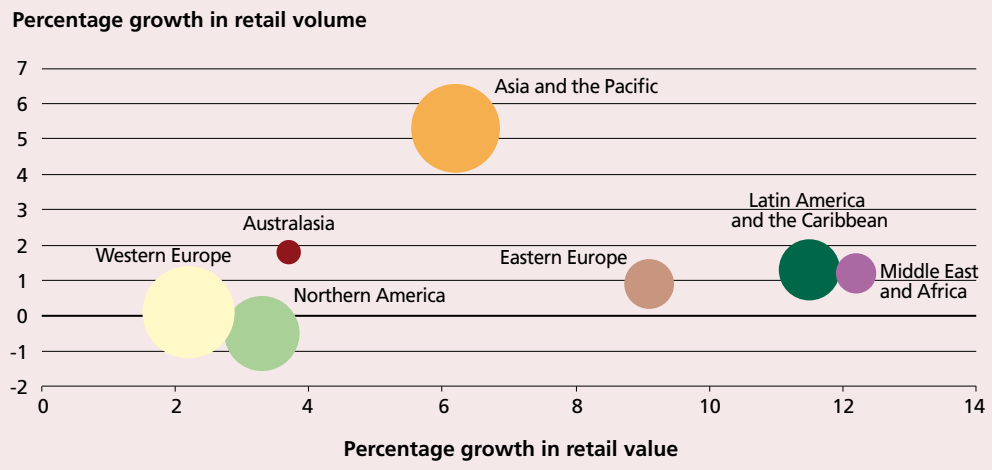
These examples show that aspects of traditional and modern systems exist in parallel and that the transformation of food systems is not a simple linear transformation from one to the other. In fact, integration between modern and traditional channels is often a key part of a corporate strategy. Following a successful business model used in Eastern Europe and in Latin America

FIGURE 8
Modern and traditional retail outlet shares of fresh fruit and vegetable market in selected countries



Notes: Countries are presented in ascending order of GDP per capita according to World Bank (2008) figures.
Sources: Kenya and Zambia: Tschirley *et al.*, 2010; Nicaragua and Mexico: Reardon, Henson and Gulati, 2010; Thailand: Gorton, Sauer and Supatpongkul, 2011; Turkey: Bignebat, Koc and Lemelilleur, 2009.

FIGURE 9
Retail sales of packaged food, by region



Notes: The size of the bubbles denotes the value of retail sales in US dollars for 2011 at fixed 2011 exchange rates and prices. The market values range from US$40.7 million in Australasia to US$581.6 million in Western Europe. Percentage growth refers to the period 2010–11.
Source: Authors' compilation using data supplied by Euromonitor.

and the Caribbean, major importers and supermarkets use packaged goods to link to traditional retailers and form mini-hubs for their products across the country. Over time, they increase their knowledge of local markets and leverage their brands to increase market share. Later, they expand into high-value fruit, vegetable, dairy and meat product categories (Hawkes *et al.*, 2010; Gorton, Sauer and Supatpongkul, 2011; Tschirley *et al.*, 2010; McKinsey, 2007; Minten and Reardon, 2008). Reardon and Timmer (2007) describe this business model in terms of waves, whereby supermarkets first enter

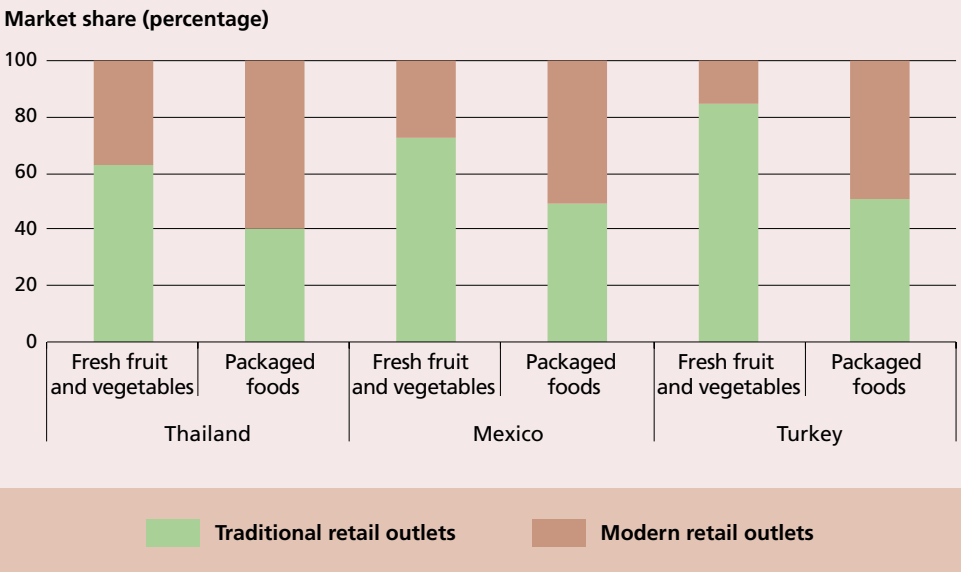
certain product categories (processed and packaged goods), geographies (urban areas first) and socio-economic segments (high-income consumers) before expanding in other areas.

This business model may be harder to implement for perishable foods such as fresh fruits and vegetables, because their production and distribution tend to be highly fragmented. Seasonal production patterns combined with the perishable nature of fresh produce make it difficult for businesses to ensure a predictable, year-round supply, which is critical for supermarkets. These products also face higher non-tariff barriers, such as quality and safety standards, that limit international trade and global procurement. They also require energy-intensive distribution infrastructure, such as refrigeration, which is often lacking in developing countries.

The market shares accruing to modern and traditional vendors in the fresh fruit and vegetable and packaged foods markets appear to support this analysis. Figure 10 shows statistics from Mexico, Thailand and Turkey, all countries with high modern supermarket penetration. Even in these countries, traditional vendors have a larger share than modern ones in sales of fresh fruits and vegetables (around 60–85 percent), while the reverse is true for packaged foods (between 40 and 50 percent). The same occurs in China, where modern retailers in the largest cities dominate packaged foods (with almost 80 percent of market share), but only around 22 percent of market share in vegetables (Reardon, Henson and Gulati, 2010).

As with fruits and vegetables, animal-source foods are also more likely to be accessed by developing-country households through traditional retail outlets (Jabbar, Baker and Fadiga, 2010). For example, around 90 percent of households in Ethiopia, across all income groups, buy their beef through a local butcher in a wet market. The situation is similar in Kenya (camel milk, meat), Bangladesh (meat, dairy) and Viet Nam (pork), with traditional shops still the predominant location for purchase, especially for low-income households (Jabbar, Baker and Fadiga, 2010). These traditional outlets, therefore, seem to be the primary point of purchase for foods that are the primary sources of micronutrients.

FIGURE 10
Modern and traditional retail outlet shares of fresh fruit and vegetable market and packaged food market in selected countries



Note: Packaged foods include breakfast foods as well as preserved, canned, frozen and other ready-to-consume items. Countries are presented in ascending order of GDP per capita according to World Bank (2008) figures.
Sources: Euromonitor, 2012 and 2011b; and Gorton, Sauer and Supatpongkul, 2011.

Traditional outlets also continue to be important for sales of staples, which contribute a large part of energy requirements. In Kenya and Zambia, traditional retail outlets account for 60 percent or more of staple sales, even in urban areas (Jayne *et al.*, 2010).

Despite the rise of modern supply chains, traditional supply chains are still important for certain products and to certain types of consumer. The advantages of traditional outlets, particularly with respect to perishable products, appear to arise from three main interconnecting factors: ability to offer products at low prices, considerable flexibility in product standards, and convenience for consumers due to flexible retail market locations (Schipmann and Qaim, 2010; Wanyoike *et al.*, 2010; Jabbar and Admassu, 2010; Minten, 2008).

Traditional retailers typically operate under structures that give them pricing advantages relative to modern supermarkets. Lower labour and overhead costs, as well as higher product turnover rates, result in lower per-unit costs. Modern supermarkets need to provide additional services (e.g. processing, sorting, re-packing, refrigeration) and control significant physical assets (e.g. buildings and equipment), which add to their costs (Goldman, Ramaswami and Krider, 2002).

These differences in cost structure appear to allow traditional retailers to develop flexible pricing strategies for different locations and different socio-economic groups. Low-income consumers in Thailand and Viet Nam overwhelmingly purchase fruits and vegetables in traditional retail outlets because of lower prices (Mergenthaler, Weinberger and Qaim, 2009; Lippe, Seens and Isvilanonda, 2010). Modern supermarkets in Thailand charge significantly higher prices than traditional outlets, even controlling for differences in product quality (Schipmann and Qaim, 2011). On the other hand, in Chile food prices in wet markets were found to be higher than those in supermarkets in higher-income neighbourhoods while the opposite was true in low-income neighbourhoods in the same city (Dirven and Faiguenbaum, 2008). Price differences between modern and traditional outlets cannot be explained simply by the relevant processing and distribution model, but can also be linked to the economic landscape surrounding the store.

Product standards and consumer expectations for traditional food value chains may also be different, permitting the marketing of foods that modern supermarkets would reject and allowing traditional outlets to lower their prices. Evidence shows that all consumers care about quality but that those who frequent traditional outlets may have different priorities than those shopping at modern retail outlets. In Madagascar, consumers purchasing from traditional retailers considered meat type and smell highly important rather than other characteristics typically valued by supermarket buyers, such as origin, date of slaughter, fat content and whether or not the product had been under constant refrigeration (Minten, 2008). Supermarket prices, especially for fresh produce and livestock, may be higher than those in traditional outlets, making micronutrient-rich foods available in supermarkets less affordable for the poor (Dolan and Humphrey, 2000; Schipmann and Qaim, 2011; Reddy, Murthy and Meena, 2010).

At the same time, proximity and convenience are major factors affecting decisions about where to shop, especially in urban areas where more choice exists (Zameer and Mukherjee, 2011; Tschirley *et al.*, 2010; Neven *et al.*, 2005; Jabbar and Admassu, 2010). Both of these factors are key advantages of traditional retailers. Small independent shops often proliferate in low-income areas, even if product selection is limited. Traditional retailers may also be more able to respond to the purchasing constraints of the poor and offer smaller, affordable quantities of goods and provide customers with shop credit if needed.

In any case, the location of traditional and modern outlets does seem to be associated with income levels. Traditional outlets are more likely to be located in low-income areas and so meet demand from low-income consumers. In contrast, modern value chains appear to be located where they can provide access to mostly urban, higher-income households. In Kenya and Zambia, for example, modern supermarkets mostly serve households in the top 20 percent of the income range (Tschirley *et al.*, 2010).

Traditional retailers also appear to be able to respond better to the demand for food from people living in more remote rural locations, regardless of their income level. This is likely to remain the case until improved roads make travel to urban areas, with their greater variety of products, easier and less time-consuming.

The coexistence of traditional and modern supply chains appears to support the availability of diverse, affordable diets for a variety of different consumers. By providing convenient access to micronutrient-rich foods at a range of price and quality combinations, traditional food outlets can support lower-income consumers in purchasing nutritious foods.

Supply chain transformation and nutrition

As the discussion above shows, a multiplicity of food options are available to today's consumers. Consumers in both urban and rural areas in developing countries still seem to favour traditional outlets (e.g. small shops, open markets) for perishable items such as fruits and vegetables, fish and meat. Supermarkets tend to be associated with urban, higher-income areas while low-income consumers, in both urban and rural areas, still do most of their shopping at traditional retailers. Consumers favour supermarkets for processed and packaged goods, although traditional outlets are also important retailers of packaged goods.

Nutritionally, the result is that traditional retail outlets are the primary place for poor consumers to access fresh foods rich in micronutrients as well as packaged goods. Interventions that can help shape nutritional outcomes through the traditional retail sector are those that can lower prices by making the supply chain more efficient and reducing waste. Better infrastructure and market access for smallholder fruit, vegetable and livestock producers can increase the diversity of foods available in rural and urban markets.

The increased availability of packaged and processed goods in traditional as well as modern retail outlets can increase the availability of energy for low-income consumers. However, such foods are often high in sugar, fats and salt and low in important micronutrients, and there is a risk that consumers could potentially replace other important elements of a diverse diet, such as fruits and vegetables, with these products. As a result, micronutrient deficiencies could potentially continue even as energy intake increases. Poorer diets could combine with other factors (such as changes in life style, reduced manual labour) and lead to increases in overweight and obesity (Harris and Graff, 2012; Garde, 2008; Caballero, 2007).

Some argue that modern value chain processors and retailers could develop products with improved nutritional characteristics, such as micronutrient fortification or reduced trans-fats. Public–private partnerships can play an important role when they facilitate the development of more nutritious foods by food manufacturers and their subsequent distribution through traditional retailers (World Economic Forum, 2009; Wojcicki and Heyman, 2010).

This analysis underscores the complexity of the transformation that supply chains are currently undergoing. Optimal diets are not a guaranteed outcome. But supply chains can be shaped to improve nutrition. In tandem with economic development and the nutrition transition, policies, programmes and investments should seek to take advantage of the transformation process to encourage provision of adequate, but not excessive, amounts of energy and of a high-quality, varied diet with sufficient micronutrients.

Enhancing nutrition through food supply chains

The discussion so far provides an insight into the types of supply chain that exist and how they channel different foods from producer to consumer. This is helpful for understanding the entry points where interventions could be used to improve nutrition. This section presents some examples and evidence of measures that can improve the nutritional performance of supply chains, including through improving their overall efficiency in enhancing the availability and accessibility of a wide diversity of foods, reducing post-harvest nutrient losses and improving the nutritional quality of foods through fortification and reformulation.

Improving supply chain efficiency

Raising the efficiency of supply chains can help meet the simultaneous challenge of lowering the costs of food to consumers and increasing the revenue of supply chain participants. Both lower prices (for consumers) and higher incomes (for smallholders and other producers) support the possibility of improving nutrition through a more adequate and varied diet.

Companies driving the transformation of modern food systems seek greater integration through vertical coordination of primary producers, input suppliers and processors. Such integration seems to hold the greatest potential for livestock and other capital-intensive food products (Swinnen and Maertens, 2006; Kaplinsky and Morris, 2001; Gulati *et al.*, 2007; Burch and Lawrence, 2007; IFAD, 2003).

In an integrated system, consumer demand and product information flow upstream from retailers to suppliers, who make contractual arrangements with producers (Reardon and Barrett, 2000). These contracts may include provision of inputs, credit and technical and marketing assistance. This can enable farmers to increase their productivity and profits through better access to inputs and timely receipt of payments (Swinnen and Maertens, 2006). To ensure that farmers do benefit and that lower costs translate into lower prices, appropriate regulatory policies that ensure a competitive manufacturing and retail sector will also be required.

At the same time, integrated actions throughout a supply chain can improve the nutrient content of foods and nutritional outcomes for consumers (Box 8). Nutrition-enhancing actions within the food supply

BOX 8

Improving livelihoods and nutrition throughout the bean value chain

Women and men in East Africa typically cultivate small farms with variable soil fertility and erratic rainfall. They have limited access to high-quality seeds, advanced production and post-harvest technologies, credit, extension or training, all of which could help to improve yields and production and reduce post-harvest losses. Typically, even if these farmers could increase production, they are not well-linked to domestic and regional markets.

In Rwanda and Uganda, a partnership involving universities, research institutions and NGOs is addressing key points in the value chain for common beans. The goal is to improve food and nutrition security by improving production, linking producers to the market and increasing consumption of more nutritious foods. To improve bean yields and bean quality, the project focuses on improving management practices and technologies. In addition to improved production practices, this includes better techniques for harvesting, drying and storing beans.

To increase the nutritional value and appeal of the beans, researchers developed improved processing procedures (de-hulling, soaking, milling, fermentation, germination and extrusion). The digestibility and nutritional value of the beans was enhanced by reducing phytates and polyphenols that limit iron uptake. To increase consumption, the project developed bean-based, protein-rich composite flours for use in cooking and baking as well as a special weaning porridge. Additional research aims to produce and market a variety of bean-flour-based snacks.

Extension materials were developed to increase knowledge about bean production and utilization. Materials cover the basics of feeding children aged 6–59 months, methods of preparing beans that reduce cooking time and enhance nutrient bio-availability, as well as how to prepare bean-based composite flour and use it in making porridges, cakes, biscuits and bread.

Source: Contributed by Robert Mazur, Professor of Sociology and Associate Director for Socioeconomic Development, Center for Sustainable Rural Livelihoods, Iowa State University, United States of America.

chain are relevant for all households, urban and rural alike, because even rural dwellers in developing countries as diverse as Malawi, Nepal and Peru buy a third or more of their food via markets (Garrett and Ersado, 2003).

Integrating smallholders into domestic food value chains continues to pose challenges. Poor performance of other aspects of the value chain, such as storage, transport and distribution, can impede smallholder market participation. Investments in public goods that support the development of transport, communication and service infrastructure can substantially reduce producer risk, improve value chain performance and so raise smallholder income.

A study in Kenya showed that investments in infrastructure can reduce the significant marketing costs smallholders incur in delivering crops to buyers. If these costs, estimated at 15 percent of retail value, could be reduced, farmer earnings could be increased without driving up food prices (Renkow, Hallstrom and Karanja, 2004). Other programmes, such as a number of public–private partnerships, have improved overall market efficiency and smallholders' ability to engage with the market by using modern communication technologies to facilitate the flow of information (Aker, 2008; de Silva and Ratnadiwakara, 2005). Policies that support the development of financial markets in rural areas can also improve the ability of small- and medium-sized traders to purchase surplus production from smallholders (Coulter and Shepherd, 1995).

Reducing nutrient waste and losses

A recent FAO report estimates that roughly one-third of food produced globally for human consumption is lost or wasted (Gustavsson *et al.*, 2011). In addition to the quantitative food losses, qualitative losses also occur as nutrients deteriorate during storage, processing and distribution. Nutrient losses occur both during on-farm storage, preservation and preparation, and during later storage, processing and transport from farms to points of sale. Rodents, insects and microbial spoilage are the main reasons for loss and the underlying causes are limitations in techniques for harvesting, processing, preservation and storage; in methods of packaging and transportation; and in infrastructure, such as storage and cooling facilities. Food waste reduces the sustainability of food systems, as more production is required to feed the same number of people, which wastes seeds, fertilizer, irrigation water, labour, fossil fuels and other agricultural inputs (Floros *et al.*, 2010).

In developing countries, most losses occur at the farm level and along the supply chain, before arriving at the consumer. Gustavsson *et al.* (2011) found that only 5–15 percent of food losses occur at the consumer level in the developing regions considered, compared with 30–40 percent in the developed regions. The consumer share of food losses and waste can be very high in specific locations; for example, the amount of food wasted in one community in New York State in the United States of America in one year was sufficient to feed everyone in the community for 1.5 months and 60 percent of the losses occurred after the food was purchased by the consumer (Griffin, Sobal and Lyson, 2009).

With such large losses, reducing post-harvest losses could increase food supplies and reduce food prices significantly (assuming efforts to reduce waste generate greater benefits than their costs). This could potentially improve affordability and diversity. The losses of some micronutrient-rich foods such as fruits and vegetables and fish are typically greater than losses of cereals. Chadha *et al.* (2011) note that in Cambodia, Lao People's Democratic Republic and Viet Nam, about 17 percent of the vegetable crop is lost due to post-harvest problems. A study covering several sub-Saharan African countries concluded that losses in small-scale fisheries reached 30 percent or more. Losses were particularly high at the drying, packaging, storage and transportation stages, with key constraints related to poor fish-handling practices and outdated techniques and facilities (Akande and Diei-Quadi, 2010).

Post-harvest food losses disproportionately affect the poor, who have less capacity for food preservation and safe storage (Gómez *et al.*, 2011). At-home techniques for preservation, packaging, storage and preparation could be adapted to preserve nutrients (Box 9). Many effective

BOX 9

Food processing, preservation and preparation in the home and micronutrient intakes

The ways in which households process, preserve and cook food also contribute to micronutrient intakes as these activities affect the bioavailability of some key micronutrients. Traditional food-processing methods can enhance micronutrient availability (Gibson, Perlas and Hotz, 2006). Germination and malting can improve the bioavailability of iron by a factor of 8–12. Soaking grains and legumes, a fairly typical household practice, can remove anti-nutrients that inhibit iron absorption (Tontisirin, Nantel and Bhattacharjeef, 2002). Gibson and Hotz (2001) describe interventions that can enhance the content and bioavailability of micronutrients in a representative daily menu for rural Malawian preschoolers. For example, soaking maize flour used for maize porridges is one intervention that enhances the absorption of micronutrients.

Traditional food preservation techniques used in the home, such as sun-drying, canning and pickling of fruits and vegetables can enhance the bioavailability of micronutrients and preserve surplus micronutrient-rich foods for year-round use (Aworh, 2008; Hotz and Gibson, 2007). A long-term study in Malawi showed that a range of traditional strategies combined with promotion of micronutrient-rich foods resulted in improvements in both haemoglobin and lean body mass and a lower incidence of common infections (Hotz and Gibson, 2007). However, traditional processes can be time-consuming and labour-intensive and some such processes can result in *decreased* micronutrient availability (Lyimo *et al*., 1991; Aworh, 2008).

Cooking using moderate heat and for short time periods as well as cooking closer to meal times, if possible, can help increase micronutrient bioavailability. For example, cooking green leafy vegetables with mild heat can increase the bioavailability of heat-sensitive nutrients such as vitamin C. Use of appropriate quantities of fat or oil in stir frying or similar methods can also increase micronutrient bioavailability, because oils facilitate absorption of certain nutrients (Tontisirin, Nantel and Bhattacharjeef, 2002).

interventions for reducing post-harvest losses are known (e.g. small-scale post-harvest storage facilities, improved pre-harvest management and/or increased food-processing opportunities); however, little is known about the impacts of such initiatives on nutrition (Silva-Barbeau *et al.*, 2005).

Enhancing the nutritional quality of foods

Fortification during processing is the most common means for improving the nutritional quality of foods.[18] Food companies can also reformulate processed foods to change the nutritional profile of the products offered. They frequently do so in response to consumer demand, for example, for foods with low-fat, low-carbohydrate, gluten-free or other nutritional attributes. Other than mandatory fortification, government policy has seldom directly influenced food reformulation for improved nutritional quality (such as reducing as trans-fats) beyond mandatory fortification.

Fortifying commonly consumed foods with specific key micronutrients can be an effective and economically efficient way to treat nutrition-related disorders. The Universal Salt Iodization initiative, which began in 1990, increased the proportion of the world's population with access to iodized salt from 20 percent to 70 percent by 2008, although iodine deficiency remains a public health problem in more than 40 countries (Horton, Mannar and Wesley, 2008). Most food fortification efforts

[18] Food fortification is "..the addition of one or more essential nutrients to a food whether or not it is normally contained in the food for the purpose of preventing or correcting a demonstrated deficiency of one or more nutrients in the population or specific population groups" (FAO and WHO, 1991).

BOX 10
The Grameen Danone Partnership

Groupe Danone, a multinational corporation, together with Grameen Bank, a Bangladeshi NGO known for expertise in micro-credit lending, founded Grameen Danone Foods (GDF) in 2006. Together with the Global Alliance for Improved Nutrition, GDF developed a yoghurt fortified with 30 percent of the recommended daily allowance (RDA) for zinc, iron, vitamin A and iodine and 12.5 percent of the RDA for calcium (Socialinnovator, 2012).

Beyond producing a fortified and nutritious yogurt targeted towards improving the nutritional needs of poor children in Bangladesh, the partnership also aimed to help the poor in the community by involving them in all stages of the value chain. The partnership set out to build up to 50 factories by 2020, with around 1 500 new jobs and 500 new milk producers associated with each factory. Although some of these goals have fallen short, there are currently up to 500 local women who sell yogurt throughout the Bogra district, making roughly US$30 per month. In addition, Rodrigues and Baker (2012) report that GDF has redesigned its plants to use milk supplied by nearby dairy farmers with five cows or fewer and who lack working refrigeration. This, in turn, is promoting local community growth in the small-scale dairy sector that once existed purely for subsistence.

GDF also now employs around 900 saleswomen, who account for about 20 percent of total sales, with the remainder generated by a network of small shops in provincial towns in the Rajshahi district and by supermarkets in Bangladesh's large cities, including Dhaka, Sylhet and Chittagong (Rodrigues and Baker, 2012).

involve key micronutrients such as vitamins A and D, iodine, iron[19] and zinc (Box 10). Condiments such as salt and soy sauce and staple foods like maize and wheat flours, as well as vegetable oils, are good candidates for fortification because they are widely consumed, and low-cost technologies can produce varieties that are acceptable to consumers (Darnton-Hill and Nalubola, 2002).

Fortified products need to reach micronutrient-deficient consumers through existing or newly established distribution channels. Based on the analysis above, traditional supply chains such as corner stores, wet markets and other small retail outlets are likely to be the most effective channels for reaching poor consumers. The companies typically involved in fortifying foods are often national and have well-established distribution and marketing networks that can effectively deliver products to urban and rural populations, although some fortification technologies are easily applied by small-scale processors who may be more effective in reaching remote populations (Horton, Mannar and Wesley, 2008).

Micronutrient fortification of staple foods and condiments is generally inexpensive and highly cost-effective. Salt iodization can reach 80–90 percent of a target population at an annual cost of approximately US$0.05 per person. Fortification of flour with iron can reach up to 70 percent of a target population for about US$0.12 per person. The costs of reaching the remaining population, often in remote areas, will be higher, but these hard-to-reach individuals may derive a proportionally higher benefit from fortification, as they are often poorer, with less-nutritious diets and less access to health care. Despite the low costs of fortification, consumer prices of fortified

[19] Some concerns have been expressed about the use of iron supplements, after some studies showed adverse effects when non-iron-deficient individuals received supplements in malarial areas. However, the doses of iron from the supplements were significantly higher than those delivered by fortification, even in populations with very high flour consumption. Expert reviews convened by WHO and UNICEF recommended iron fortification of staple foods, condiments and complementary foods even in areas affected by high malaria transmission rates because this avoids the need for preventive supplementation. Other reviews have found that fortification with appropriate levels of iron is also safe for the small proportion of people with clinical disorders relating to iron absorption and storage (Horton, Mannar and Wesley, 2008).

products such as iodized salt may be higher because such products are usually refined, packaged, branded and marketed in ways that add costs beyond those associated with fortification itself (Horton, Mannar and Wesley, 2008).

Fortification programmes entail a range of initial costs, including population-based needs assessments, trials to determine appropriate foods and micronutrient levels, industry start-up costs, development of appropriate communication and social marketing programmes, and capacity-building for public-sector regulation, enforcement, monitoring and evaluation. The incremental cost of flour fortification may be perceived by millers as significant if the market environment does not enable them to recover the cost because of factors such as low consumer demand for fortified products or government controls on the price of the product. When the incremental cost of fortification cannot be sustained by millers or passed directly to the consumer, governments may assist with subsidies or tax exemptions. In some cases, such costs have been partially subsidized by international support through organizations such as the Micronutrient Initiative and the Global Alliance for Improved Nutrition, as well as other donors (Horton, Mannar and Wesley, 2008).

At the same time, consumer demand for fortified foods can be strengthened through education and marketing campaigns. This may involve public–private partnerships that work through existing manufacturing and distribution associations and build on the existing marketing strategies of the member firms. In West Africa, for example, the NGO Helen Keller International is working with the Association of Edible Oil Producing Industries to educate consumers about the benefits of vitamin A and promote the use of fortified cooking oil (Helen Keller International, 2012). These promotional and education campaigns include strong in-store support for nutrition education.

Conclusions and key messages

Traditional and modern value chains play complementary roles in providing consumers in urban and rural areas with available, accessible, diverse and nutritious foods. Each offers distinct challenges and opportunities for improving the nutritional performance of food systems.

Traditional marketing channels deliver nutritional benefits to low-income residents in urban areas, where they enjoy cost and location advantages, and to rural residents who are largely missed by modern value chains. Traditional value chains are a good source of affordable, micronutrient-rich foods, but poor post-harvest storage and distribution infrastructure can lead to significant food losses and deterioration in nutritional quality. Traditional value chains suffer from seasonal shortages and high transaction costs that can offset their ability to offer low prices. Interventions to improve the efficiency of traditional food value chains can be effective in improving access to micronutrients, particularly among poor people.

In contrast, modern value chains tend to have more efficient distribution chains, with better year-round availability of a wide variety of foods. They increase the availability of highly processed packaged goods, which may contribute to problems of overweight and obesity. The ability of modern food manufacturers to distribute processed and packaged foods through traditional marketing channels allows them to reach remote rural areas and urban neighbourhoods where residents have little or no access to modern supermarkets. This may reduce undernutrition for poor rural and urban residents while increasing overnutrition for more affluent consumers. At the same time, the increased availability of processed and packaged goods offers opportunities for collaboration among food manufacturers, donors and governments to implement profitable and socially beneficial food fortification initiatives that target micronutrient deficiencies.

This analysis highlights the interactions between traditional and modern value chain participants and suggests the need for a more nuanced view of the links between food chains and nutrition. Two issues in particular warrant rigorous investigation. First, very little evidence exists regarding the contribution of different traditional and modern supply chains on micronutrient deficiencies. Second, very little is known about demand substitution effects among

processed and packaged foods, staples, fruits, vegetables and livestock products, and about how consumers respond to changes in relative prices of these product categories.

Key messages

- Traditional and modern food supply chains are changing rapidly to provide consumers with a diverse range of foods. They tend to serve different population groups and specialize in different types of food, yet both offer challenges and opportunities for improving nutrition. Understanding how food supply chains are changing can help policy-makers target interventions more effectively.
- Traditional supply chains are the primary channel through which low-income consumers in urban and rural areas purchase food. Enhancing the efficiency of traditional value chains can promote better nutritional outcomes by improving access by low-income consumers to safe, nutrient-dense foods, such as fruits, vegetables and livestock products.
- Modern supply chains play an important role in preserving the nutritional content of food and increasing the year-round availability and affordability of a diverse range of foods. The growth of modern food processing and retailing facilitates the use of fortification to combat specific micronutrient deficiencies, but also increases the availability of highly processed, packaged goods that may contribute to overweight and obesity.
- Reducing food and nutrient losses and waste throughout the food system can make an important contribution to better nutrition and also relieve pressure on productive resources. In low-income countries, most food and nutrient losses occur before products reach the consumer, that is, at the farm level and during storage, processing and distribution. In high-income countries, most losses and waste occur at the consumer level.