HLPE REPORT 12

Nutrition and food systems

A report by

The High Level Panel of Experts

on Food Security and Nutrition

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Contents

List of Figures

List of Definitions

List of Tables

List of Boxes

FOREWORD

The High Level Panel of Experts for Food Security and Nutrition (HLPE) is the science-policy interface of the Committee on World Food Security (CFS), which is, at the global level, the foremost inclusive and evidence-based international and intergovernmental platform for food security and nutrition (FSN).

The HLPE reports serve as a common, comprehensive, evidence-based starting point for intergovernmental and international multi-stakeholder policy convergence in CFS. The HLPE draws its studies based on existing research and knowledge. The HLPE strives to clarify contradictory information and knowledge, elicit the backgrounds and rationales of controversies and identify emerging issues. To do so, it organizes a scientific dialogue, among Steering Committee and Project Teams members, and with the experts and knowledge communities involved in the open electronic consultations and in the external peer-reviews of the reports. This dialogue builds upon a wide diversity of disciplines, backgrounds and knowledge systems.

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Globally, one person in three is malnourished today and one in two could be malnourished by 2030 if nothing is done. Building on the international political momentum created around nutrition by the 2030 Agenda, the 2014 Rome Declaration on Nutrition and the subsequent United Nations (UN) Decade of Action on Nutrition (2016–2025), the CFS, at its 42nd Plenary session in October 2015, requested the HLPE to prepare a report on *nutrition and food systems*, to be presented at CFS 44 in October 2017.

While hunger remains a critical concern, overweight and obesity are rapidly increasing all over the world, including in low- and middle-income countries. Therefore, malnutrition in all its forms (undernutrition, micronutrient deficiencies and overweight and obesity) now affects all countries, whether low-, middle- or high-income. Those different forms of malnutrition can co-exist within the same country or community, and sometimes within the same household or individual, and can even paradoxically be linked: they thus must be fought altogether.

As a consequence, hunger and malnutrition will not be "self-corrected" only by economic growth, as many people thought in the past: nor will these concerns be spontaneously addressed. On the contrary, nutrition must be integrated as an explicit objective in national policies, programmes and budgets, not only in low-income but also in high-income countries. Cross-sectoral nutrition strategies should be designed and implemented at different levels, from global to local.

Every human being has the right to adequate food. However, the progressive realization of this right will not be achieved without more sustainable food systems that facilitate healthy and sustainable food choices and ensure FSN for all, including vulnerable people with specific nutrient requirements (such as young children, adolescent girls, pregnant and lactating women, the elderly and ill people), or marginalized people with less control over their diets (such as the poor, as well as some indigenous peoples).

Current food systems have dramatic effects on human and planetary health. They shape producers' decisions and consumers' food choices. Nevertheless, this report demonstrates that human decisions and choices (whether individual or collective) regarding production and consumption can also influence food systems and improve their ability to deliver healthy and sustainable diets. In this context, the purpose of this report is two-fold.

First, the report analyses how food systems influence people's dietary patterns and nutritional status. The conceptual framework proposed by the HLPE identifies three interacting elements of food systems, i.e. food supply chains, food environments and consumer behaviour. It highlights the central role of the food environment (i.e. the physical, economic, political and socio-cultural context in which each consumer engages with the food system) in facilitating healthy and sustainable consumer food choices.

Second, the report calls for radical transformations. Within such a perspective, it presents effective policies and programmes that have the potential to shape food systems, contributing to improved FSN. Improved food environments are absolutely needed for the effective realization of the right to adequate food. I would like to highlight here two concrete priorities for action: (i) improve the physical and economic access to healthy and sustainable diets; and (ii) strengthen consumers' information and education to enable healthier food choices.

This report draws on the previous HLPE reports, many of which are highly relevant to various aspects of food systems, including the reports on sustainable agriculture and livestock, fisheries and aquaculture, and food losses and waste. As diversity is of paramount importance, short case studies illustrate a wide variety of practical experiences in different food systems and contexts.

The report provides a set of action-oriented recommendations addressed to states and other stakeholders in order to inform CFS engagement in advancing nutrition and the CFS contribution to the UN Decade of Action. While emphasizing the need for solutions that are context-specific, the report also highlights the need for consistent action at all levels. I hope that the findings and recommendations of this report will not only facilitate the policy convergence work in CFS but also inspire many stakeholders in contributing to progress towards more sustainable food systems and enhanced FSN.

The multiple burdens of malnutrition are enormous and raise ethical, political and economic concerns. In front of this challenge, action cannot wait and all stakeholders together will have to make adapted and feasible but bold decisions. The short-term costs of the actions outlined in this report may seem high, but the cost of inaction is likely to be much higher, carrying with it a terrible legacy affecting future generations.

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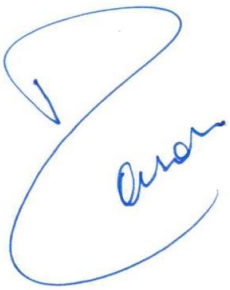
On behalf of the HLPE Steering Committee, I would like to acknowledge the engagement and commitment of all the experts who worked for the elaboration of this report, and especially the HLPE Project Team Leader, Jessica Fanzo (United States of America) and Project Team Members: Mandana Arabi (Iran), Barbara Burlingame (New Zealand), Lawrence Haddad (United Kingdom), Simon Kimenju (Kenya), Gregory Miller (United States of America), Fengying Nie (China), Elisabetta Recine (Brazil), Lluís Serra-Majem (Spain) and Dipa Sinha (India).

I would like to commend and thank the HLPE Secretariat for its precious support to the HLPE work.

This report also benefited greatly from the suggestions of the external peer reviewers and from the comments provided by a large number of experts and institutions, both on the scope and on the first draft of the report.

Last but not least, I would like to thank the resource partners who support the work of the HLPE in a totally independent way.

Patrick Caron



Chairperson, Steering Committee of the HLPE, 25 September 2017

SUMMARY AND RECOMMENDATIONS

At its 42nd session in October 2015, the Committee on World Food Security (CFS) requested the High Level Panel of Experts on Food Security and Nutrition (HLPE) to prepare a report on *Nutrition and Food Systems*, to be presented at CFS 44 in October 2017. This topic is highly relevant to the Sustainable Development Goals (SDGs), the implementation of the 2014 Rome Declaration on Nutrition, the subsequent Decade of Action for Nutrition, and the fulfilment of the right to adequate food.

The purpose of this report is two-fold: (i) to analyse how food systems influence people's dietary patterns and nutritional outcomes; and (ii) to highlight effective policies and programmes that have the potential to shape food systems, contribute to improved nutrition and ensure that food is produced, distributed and consumed in a sustainable manner that protects the right to adequate food for all. This report is illustrated by short case studies reflecting the wide variety of practical experiences in different contexts. It also provides a set of action-oriented *recommendations* addressed to states and other stakeholders in order to inform *CFS engagement in advancing nutrition* and CFS contribution to the UN Decade of Action on Nutrition (2016–2025).

Summary

Setting the stage: approach and conceptual framework

1. This report aims to analyse how food systems influence diets and nutrition. It offers three significant additions to previous frameworks. First, it emphasizes the role of diets as a core link between food systems and their health and nutrition outcomes. Second, it highlights the central role of the food environment in facilitating healthy and sustainable consumer food choices. Third, it takes into account the impacts of agriculture and food systems on sustainability in its three dimensions (economic, social and environmental).
2. A *food system* gathers all the elements (environment, people, inputs, processes, infrastructures, institutions, etc.) and activities that relate to the production, processing, distribution, preparation and consumption of food, and the outputs of these activities, including socio-economic and environmental outcomes. This report pays specific attention to nutrition and health outcomes of food systems. It identifies three constituent elements of food systems, as entry and exit points for nutrition: food supply chains; food environments; and consumer behaviour.
3. The *food supply chain* encompasses all activities that move food from production to consumption, including production, storage, distribution, processing, packaging, retailing and marketing. The decisions made by the many actors at any stage of this chain have implications for other stages. They influence the types of food available and accessible, as well as the way they are produced and consumed.
4. The *food environment* refers to the physical, economic, political and socio-cultural context in which consumers engage with the food system to acquire, prepare and consume food. The food environment consists of: "food entry points", i.e. the physical spaces where food is obtained; the built environment that allows consumers to access these spaces; personal determinants of food choices (including income, education, values, skills, etc.); and the political, social and cultural norms that underlie these interactions. The key elements of the food environment that influence food choices, food acceptability and diets are: physical and economic access to food (proximity and affordability); food promotion, advertising and information; and food quality and safety.
5. *Consumer behaviour* reflects the choices made by consumers, at household or individual levels, on what food to acquire, store, prepare and eat, and on the allocation of food within the household (including gender repartition, feeding of children). Consumer behaviour is influenced by personal preferences determined by taste, convenience, culture and other factors. However, consumer behaviour is also shaped by the existing food environment. Collective changes in consumer behaviour can open pathways to more sustainable food systems that enhance food security and nutrition (FSN) and health.
6. These three components of food systems impact consumers' capacity to adopt *sustainable diets* that are: protective and respectful of biodiversity and ecosystems; culturally acceptable;

accessible; economically fair and affordable; and nutritionally adequate, safe and healthy, while optimizing natural and human resources.

7. A wide variety of food systems and food environments can exist or co-exist at local, national, regional and global levels. The typology suggested in this report evaluates food systems along *both* food supply chains and the food environment. It identifies three broad types of food systems: (1) traditional food systems; (2) mixed food systems; and (3) modern food systems.

8. In *traditional food systems, consumers* rely on minimally processed seasonal foods, collected or produced for self-consumption or sold mainly through informal markets. Food supply chains are often short and local, thus access to perishable foods such as animal source foods (ASF) or certain fruits and vegetables can be limited or seasonal. Food environments are usually limited to one's own production and informal markets that are daily or weekly and may be far from communities.

9. In *mixed food systems*, food producers rely on both formal and informal markets to sell their crops. Highly-processed and packaged foods are more accessible, physically and economically, while nutrient-rich foods are more expensive. Frequent branding and advertising accompany everyday activities, seen on billboards and in print publications, while food labelling is sometimes provided in markets. Even when food-based dietary guidelines are available, most consumers have little or no access to this information. Food safety and quality standards exist, but may not always be followed by producers.

10. *Modern food systems* are characterized by more diverse food options all year long, and by processing and packaging to extend food's shelf life. These systems include both formal and easily accessible markets in high-income areas and food deserts[1] and food swamps[2] in low-income areas. While the cost of staples is lower relative to ASF and perishable foods, specialty foods (e.g. organic, local) are more expensive. Consumers' access to detailed information on food labels, store shelves, and menus and food is highly promoted. Food safety is monitored and enforced, and storage and transport infrastructures (including cold chain) are generally prevalent and reliable.

The multiple burdens of malnutrition

11. Globally, one person in three is malnourished. If current trends continue, one in two could be by 2030, in stark contrast with the objective to end all forms of malnutrition by 2030. Malnutrition takes different forms: undernutrition (underweight, stunting and wasting); micronutrient deficiencies; and overweight and obesity. These forms of malnutrition affect all countries, whether developed or developing and can also co-exist within countries, communities, households and individuals.

12. *Undernutrition:* globally, despite the progress made over the last decades, almost 800 million people are still undernourished, 155 million children under five years of age remain stunted;[3] and 52 million are wasted.[4] Undernutrition explains around 45 percent of deaths among children under five, mostly in low- and middle-income countries (LMICs). The current crisis, with four countries (Nigeria, Somalia, South Sudan, Yemen) facing famines, is also likely to derail some of this progress.

13. *Micronutrient deficiencies* refer to inadequate intake of vitamins and minerals. Those of greatest public health concerns are Vitamin A, iron and iodine. Vitamin A deficiency is the leading cause of preventable blindness in children and increases the risk of disease and death from infections. Iron-deficient anaemia is of significant concern for many women around the world leading to low cognition and work productivity. Iodine deficiency during pregnancy can compromise children's mental health and even survival. Other important deficiencies are Vitamin D, B12, folate, calcium and zinc.

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[1] i.e. geographic areas where residents' access to food is restricted or non-existent due to the absence or low density of "food entry points" within a practical travelling distance.

[2] i.e. areas where there is an overabundance of "unhealthy" foods but little access to "healthy" foods.

[3] Meaning that they have a low height-for-age, which is an indicator of chronic undernutrition.

[4] Meaning that they have a low weight-for-age, which is an indicator of acute undernutrition.

14. *Overweight and obesity* are rising quickly and affect all countries. Worldwide obesity has more than doubled since 1980. In 2014, a staggering 1.9 billion adults were overweight, of which 600 million were obese. In 2014, an estimated 41 million children under five were overweight, a quarter living in Africa and almost half in Asia. These rising rates are linked to increases in diet-related non-communicable diseases (NCDs) such as cancer, cardiovascular disease and diabetes. Overweight and obesity are now associated with more deaths worldwide than underweight.

15. Malnutrition affects the entire life cycle and its effects can extend across generations. Some groups are particularly vulnerable to malnutrition, including those with specific nutrient requirements at critical stages of their life cycle (such as young children, adolescent girls, pregnant and lactating women, the elderly and people who are ill are immuno-compromised) or marginalized groups that have less control over their diets (such as the urban and rural poor, as well as some indigenous peoples). Malnutrition during the first 1 000 days of life increases the risk of morbidity and mortality and limits children's mental and physical growth to levels far below their full genetic potential, having important consequences for their whole life.

16. Traditional food systems currently are associated with the highest prevalence of undernutrition, including stunting, wasting and under five mortality, as well as the highest prevalence of micronutrient deficiencies but with lower levels of overweight and obesity in adults. All burdens of malnutrition co-exist in mixed food systems: this is a challenge in terms of prioritizing policies and programmes to tackle these multiple burdens. Finally, modern food systems are associated with lower levels of undernutrition and micronutrient deficiencies but higher levels of overweight and obesity.

Diets in transition

17. Global dietary patterns have been changing rapidly in recent decades. With globalization, urbanization and income growth, people are experiencing new food environments, expanding their food choices and diversifying their dietary patterns in both positive and negative directions.

18. In some low-income countries (LICs), many of the poor eat grain- or tuber-dominated diets low in micronutrients, as this is what is accessible and affordable. While traditional foods such as legumes, seasonal fruits, leafy vegetables and forest foods fill some nutrient gaps, other fresh fruits and vegetables as well as ASF often remain costly and inaccessible. As households' incomes rise, the consumption of foods associated with both healthy and unhealthy diets generally increases. High-income households tend to rely less on staple grains and more on ASF, fruits and vegetables. However, they also tend to consume more foods high in sugar, salt and saturated and trans fats such as highly-processed and packaged foods, sugar-sweetened beverages, red and processed meats. Snacking and eating away from home also tend to increase, with less cooking taking place at home.

19. The *nutrition transition* refers to changes in lifestyle and dietary patterns driven by urbanization, globalization and economic growth, and their resulting impacts on nutrition and health outcomes. As countries urbanize and become wealthier, in general, obesity rises. However, these global trends should not hide the significant diversity of diets around the world, reflecting the diversity of food production landscapes and ecosystems, socio-economic conditions, cultures and beliefs. Studies of food systems adapted to their local context and of the associated traditional knowledge built up over millennia can provide new insights and pathways towards more sustainable food systems.

20. Significant increases in ASF consumption are projected in developing countries, with mixed results on nutrition: while LICs may struggle to increase ASF consumption to the levels necessary to reverse micronutrient deficiencies, middle-income countries (MICs) and high-income countries (HICs) risk overconsuming ASF with negative impacts on health. Reversing such trends remains a significant concern, including for the sustainability implications of ASF supply, considering the complex impacts of ASF on health, nutrition status and the environment. In an interconnected, globalized food system, balancing human and planet health also presents significant policy challenges: some diets, such as the Mediterranean diet, provide useful insights to tackle this issue.

21. Food safety remains an important issue. Low safety levels in the food supply and poor water quality contribute to diarrhoea and other communicable diseases in both urban slums and rural areas. Children under five are most at risk, bearing 40 percent of the food-borne disease burden. Lack of infrastructure, including a cold chain, in many LICs can render perishable foods unsafe and increase the risk of pathogen transmission along the food supply chain. Strong institutions are crucial to foster the needed investments and to design and enforce food regulations and standards.

Drivers of food system changes

22. The report identifies five main categories of drivers of food system changes that influence nutrition and diets: biophysical and environmental; innovation, technology and infrastructure; political and economic; socio-cultural; and demographic drivers.

23. *Biophysical and environmental drivers.* Food production is heavily dependent on biodiversity and ecosystems, including not only agriculture but also forests, aquatic ecosystems and mosaic landscapes. Agricultural systems and food supplies are becoming increasingly homogeneous and dependent on a small number of 'global' crops, including major cereal and oil crops. At the same time, agricultural practices are increasingly moving towards intensified monoculture, which may improve grain yields in the short term but limits the biological diversity necessary for high-quality diets. Climate change and variability, as well as more severe and frequent floods and droughts, will impact health, productivity, and resilience of ecosystems, communities and households, particularly for the most vulnerable. Food systems need to adapt to climate change and can also significantly contribute to its mitigation.

24. *Innovation, technology and infrastructure drivers.* Innovation has been a major engine for food system transformation in the past decades and will be critical to address the needs of a rapidly growing population in a context of climate change and natural resource scarcity. Building more sustainable food systems to enhance FSN will require not only new research and new technologies, but also better access to and use of existing technologies, developing context-specific solutions for local ecosystems, adapted to local socio-economic and socio-cultural conditions. More investment is needed in research and development of nutritious food crops (such as fruits, vegetables and pulses, as well as neglected and orphan crops) as opposed to major staple commodities. The limitations and potential risks of technologies for FSN, health, livelihoods and the environment must also be considered. Infrastructure, especially for food transportation, needs to be improved and equitably accessible.

25. *Political and economic drivers.* Leadership, as well as inclusive governance mechanisms, from global to local levels, is crucial: to invest in sustainable food systems; to design and implement policies and programmes to strengthen food systems, improve diets and enhance FSN; and to overcome power imbalances. Accountability and sustained commitment require significant political will. Political and economic drivers also include: globalization, foreign investment and trade; food policies, including food-based dietary guidelines and taxes and subsidies; food prices and price volatility; land tenure; conflicts and humanitarian crises. In situations of conflicts and protracted crises, there is a critical need for nutrition-sensitive interventions that link humanitarian response with longer-term strategies to strengthen the resilience of food systems and improve FSN.

26. *Socio-cultural drivers.* Individual food choices, although deeply personal, also reflect cultures, rituals and social traditions. Food is an important part of culture, particularly for indigenous peoples: the types of foods we consume and the way we prepare and eat those foods, with whom and where, are repositories of traditions and shape cultural identity. Food systems and food environments are consistently shaping cultures and traditions and vice versa. Gender relationships and norms are among the most significant drivers of food environments and diets. Women can influence the household diet and, as primary caregivers, have an influence on children's nutritional status. Therefore, women and girl's empowerment, through education, information and access to resources and services, is key for FSN.

27. *Demographic drivers.* Population growth and changing age distribution, urbanization, migration and forced displacement have driven radical changes in food systems and diets in the past decades and will remain major drivers in the future. The concentration of population growth in the poorest countries will make it harder for these governments to combat hunger and malnutrition. Urbanization is expected to put additional stress on food systems through increased demand for

a greater diversity of foods. Urban demand will increasingly dictate what foods are grown by rural producers and how these foods are processed, distributed and marketed. Food insecurity can be both a cause and consequence of migration and forced displacement. There is growing concern regarding the number of children who are migrating due to conflicts, and facing an increased risk of malnutrition due to lack of access to healthy diets as well as social services.

Positive directions for food systems, diets and nutrition

28. Many promising programmes and policies to reduce the multiple burdens of malnutrition are currently being piloted, tested and scaled. Food systems allow many points for intervention – across the supply chain, within food environments and related to consumer behaviour. Intervention is also possible throughout the various drivers that affect food systems, directly or indirectly.

29. The *food supply chain* impacts diets and nutrition positively and negatively by creating entry and exit points for nutrition, affecting the nutritional value of the food produced. Supply chains are a point of leverage for agriculture to improve nutrition, particularly through traditional production systems focused on micronutrient-rich foods. Supply chains impact how foods are processed, distributed and marketed – activities that can all affect the nutritional quality of foods accessible in a given food environment. Nutrition awareness among actors along the supply chain can also motivate them to maximize nutrition entering the chain.

30. Improved *food environments* allow consumers to purchase and consume more nutritious and healthy foods. Although a substantial body of research describes food environments in HICs – particularly in urban settings – less is available on LMICs. Factors that limit access to nutritious and healthy foods include economic constraints, lack of knowledge and resulting low demand. Nevertheless, policies and programmes focused on the food environment have been implemented worldwide, including approaches aimed to: improve access to nutritious and healthy foods in food deserts; provide healthy options in public establishments; and promote healthier diets through regulations and standards, taxes, subsidies, trade policies, labelling and advertising.

31. Regulation, information and education can *orient consumers* towards healthier and more sustainable food choices. Mass media campaigns, social and behaviour change communication, social protection programmes and food-based dietary guidelines all serve to increase awareness and influence consumer behaviour. Evidence suggests that information and education alone may not trigger significant changes and that communication programmes must incorporate insight on actionable steps to change habits to be more effective. Promoting traditional foods, cooking and empowering consumers, especially women, to be nutrition champions of healthy diets all serve to shape diet choices.

32. Each food system, whether traditional, mixed or modern, faces its own challenges, but all of them have the potential to open specific pathways towards sustainability and healthier diets that enhance FSN now and in the future. “Modern” food systems should not be seen as the end goal. Traditional food systems, and their associated knowledge systems, have inherent value and can be a source of inspiration for policy-makers. These three types of food systems all need adapted improvements to deliver healthier diets and enhance FSN for all people.

33. In *traditional food systems*, policies and programmes should focus on availability and accessibility of healthy diets. These might involve strategies to protect farmers, especially smallholders, often net buyers of food, who are particularly vulnerable to external shocks. Investments in infrastructure and storage facilities that allow for safer storage and easier transport of food, and integration of technologies such as food fortification and processing, could also help people meet their dietary needs. Interventions should also support the affordability of a healthy diet, including protein- and micronutrient-rich foods.

34. In *mixed food systems,* policies and programmes aimed at strengthening food safety and improving infrastructure are important, particularly in the informal sector. Moreover, these food systems could also be improved by the introduction of price incentives (for instance through taxes and subsidies), marketing restrictions, improved labelling, promotions and incentives for nutritious foods and zoning incentives to increase access to retailers selling nutritious foods in low-income areas.

35. In *modern food systems*, policy-makers should focus on encouraging the availability and accessibility of diverse and healthy diets, particularly for the marginalized and the most vulnerable. They should aim to limit the consumption of highly-processed and nutrient-poor foods by targeting the industries that produce them (e.g. through marketing restrictions, content restrictions and labelling requirements for trans fats and added sugars) as well as consumers (e.g. through subsidies and taxes; nutrition education). Such policies could mitigate some of the negative health consequences generally associated with modern food systems.

Translating evidence into action

36. The motivation to act is strong but there are many barriers to developing and implementing effective policies and programmes. Action requires recognizing the right to food and prioritizing this rights-based perspective for the most vulnerable. Although recent pledges by governments, and the SDGs themselves, emphasize rights-based approaches, many countries still fail to recognize this right. Power struggles present challenges as transnational food corporations use their economic power to hinder political action to improve food systems and diets. Conflicts of interest also disrupt goals, occurring when the policies or practices of an individual or institution differ from health and nutrition goals. Salient examples include food and beverage marketing in unhealthy food environments and advertising foods high in fat, sugar and salt to children as well as biased industry funding for research.

37. Enabling environments are those in which governments have the political will as well as the coordination, accountability and effective responses necessary to improve nutrition and meet the needs of the marginalized and the most vulnerable. The multi-sectoral nature of malnutrition requires individual, institutional and system-level collaborative engagement and coordination. Coordination is necessary both *vertically* (among different ministries and from the national to the local level) and *horizontally* (across sectors and multiple stakeholders). Effective implementation further requires clear definitions of the roles and responsibilities of all stakeholders and accountability based on trust, inclusiveness, transparency and verification. Effective responses also depend on surveillance and monitoring.

38. Success will require more investment in nutrition, financially and in human capacity and social movements, coalitions and networks. Improving FSN requires large investments but could provide significant long-term benefits in reducing health costs and encouraging economic growth in LMICs.

39. The nutrition community must seize this moment to make the UN Decade of Action on Nutrition meaningful, action-oriented and impactful. To do so, the global community should embrace the SDGs as interlinked and address simultaneously all forms of malnutrition. This will require everyone who interacts with food systems and the food security mandate to act. Food supply chain and food environment actors, whether small or large, need to be valued and supported to shift towards nutrition-sensitive agriculture and food systems. Solutions need to be adapted to fit changing consumer demands, preferences and tastes.

Recommendations

The following set of recommendations, building upon the main findings of this report, is a contribution to the progressive realization of the right to adequate food and nutrition. Food systems shape people's diets, their health and nutrition outcomes and their overall well-being. The way food is produced, distributed and consumed also impacts the integrity of the planet and the stability of nations.

Overarching recommendations

1. STRENGTHEN THE INTEGRATION OF NUTRITION WITHIN NATIONAL POLICIES, PROGRAMMES AND BUDGETS

States should, in collaboration with affected stakeholders:

a) Recognize the diversity of food systems (traditional, mixed, modern) and design context-specific policies and programmes that support the co-existence of diverse food systems and diets.
b) Integrate a nutrition-focused food system approach into national development, health and economic plans.
c) Facilitate an inclusive dialogue and develop nutrition strategies at national and local levels, which focus on improving food environments.
d) Foster policy coherence in order to improve diets and nutrition, through enhanced coordination across sectors, including agriculture, environment, energy, water, sanitation and hygiene (WASH), health, education, fiscal policies, economic and social development.
e) Increase the allocation for nutrition spending in national budgets and look for the greatest synergies for improved nutritional outcomes within existing spending on agriculture and food systems.
f) Improve food and nutrition literacy throughout society through popular education programmes and other appropriate schemes.
g) Improve capacity by investing in a workforce of nutrition practitioners, and by educating a new generation of food system professionals on nutrition.

2. STRENGTHEN GLOBAL COOPERATION TO END HUNGER AND MALNUTRITION

States and inter-governmental organizations (IGOs) should:

a) Increase the share of official development assistance (ODA) to support more sustainable food systems, to address all forms of malnutrition, and to prevent diet-related non-communicable diseases.
b) Avert devastating, costly famines, by strengthening local food systems and longer-term development support, and by investing in humanitarian aid that supports communities' capacities and resilience.

3. ADDRESS THE IMPACTS OF TRADE AND INVESTMENT AGREEMENTS ON FOOD ENVIRONMENTS AND DIETS

States and IGOs should:

a) Through the use of *ex-ante* assessment, ensure that multilateral and bilateral trade and investment agreements do not have a negative impact on food environments and diets.
b) Ensure that multilateral and bilateral trade and investment agreements are consistent with nutrition policies and favour the transition towards more sustainable food systems.

4. ADDRESS THE NUTRITIONAL VULNERABILITIES OF PARTICULAR GROUPS

States and IGOs should:

a) Take specific measures to ensure that vulnerable and marginalized groups (including young children, adolescent girls, pregnant and lactating women, the elderly, people who are ill or immuno-compromised, the rural poor and indigenous peoples) are able to access or achieve a sufficient, diverse, nutritious diet that is culturally appropriate.

5. IMPROVE NUTRITIONAL OUTCOMES BY ENHANCING WOMEN'S RIGHTS AND EMPOWERMENT

States and IGOs should:

a) Ensure that laws and policies provide men and women equal access to resources including land, financial and technical resources, water and energy.
b) Recognize and value the importance of unpaid care work for human health and FSN. Facilitate the preparation of nutritious food at the household level, recognizing the time this requires. Promote the redistribution of unpaid care work within the household.
c) Strengthen rural women's participation and representation at all levels of policy-making for FSN, to ensure their perspectives are taken into account.
d) Create an enabling environment to promote breastfeeding, ensuring that decisions to breastfeed do not result in women losing their economic security or any of their rights.

6. RECOGNIZE AND ADDRESS CONFLICTS OF INTEREST

States, IGOs and other stakeholders should:

a) Identify and acknowledge conflicts of interest (COIs) as well as imbalanced power relationships between stakeholders, and establish participatory mechanisms in order to address them in policy-making and implementation.
b) Ensure transparency and accountability mechanisms, using SMART (specific, measurable, achievable, realistic and time-bound) indicators and commitments that are captured through coordinated, open access monitoring systems to prevent and address COIs.
c) Protect nutrition sciences against undue influence and corruption, including protecting scientists from retaliation and intimidation, through appropriate rules, effectively monitored and enforced.

7. IMPROVE DATA COLLECTION AND KNOWLEDGE-SHARING ON FOOD SYSTEMS AND NUTRITION

States, IGOs, the private sector, academic institutions and civil society organizations (CSOs) should:

a) Promote nutrition-focused, policy-relevant research on food systems and food demand, using an interdisciplinary systems approach, to understand the drivers and determinants of food environments and food choices as well as the gaps in evidence on such decisions.
b) Improve the availability (through open access where appropriate) and quality of multi-sectoral information systems that capture diet, food composition and nutrition-related data for improved policy development and accountability, including through the promotion of harmonized methods for data collection.
c) Invest in participatory systems for the sharing of knowledge and best practices among stakeholders in the food supply chain, while respecting the intellectual and cultural property rights of indigenous peoples.
d) Draw on the knowledge, experience and insights of individuals who are not usually regarded as members of the nutrition community – e.g. community leaders, chefs, supermarket buyers, influencers on social media, youth leaders, young entrepreneurs, mayors and local communities.

Recommendations across food supply chains, food environments and consumer behaviour

8. ENHANCE OPPORTUNITIES TO IMPROVE DIET AND NUTRITION OUTCOMES ALONG FOOD SUPPLY CHAINS

States, IGOs, the private sector and CSOs should:

a) Support initiatives that contribute to the production of nutritious, locally-adapted foods and contribute to dietary quality and diversity, including by:
   - safeguarding and supporting Globally Important Agriculture Heritage Systems;
   - providing incentives to produce nutritious foods and protect local agrobiodiversity;
   - providing incentives for agro-ecological and other types of environmentally-friendly farming practices;
   - promoting nutritious foods and sustainable diets along food supply chains.

b) Protect and enhance nutritional value along food supply chains, including by:
   - improving connectivity between rural, peri-urban, and urban supply and demand in order to propose to consumers a greater diversity of nutritious foods and support local economies, through appropriate infrastructure, markets and technologies, including e-commerce;
   - developing and promoting policies, practices and technologies that protect or add nutritional value;
   - promoting practices and technologies to improve food safety and reduce food quality losses and waste, paying special attention to aflatoxins.

c) Ensure the food supply is healthy for the consumer, including by:
   - providing financial and promotional incentives for retailers and food outlet owners, including street food vendors, to sell safe foods, made with less sodium and a higher proportion of healthy oils, fruits and vegetables;
   - protecting consumer health by establishing a monitoring system to reduce chemical and microbiological contamination of food and water supplies;
   - improving food safety governance and control through appropriate institutions and policies along food supply chains, as well as through innovations and technologies, labelling and standards, monitoring and surveillance.

9. IMPROVE THE QUALITY OF FOOD ENVIRONMENTS

a) CFS should consider the opportunity to elaborate voluntary guidelines on improved food environments for healthy diets.

States, IGOs, the private sector and CSOs should:

b) Make nutritious foods more accessible and convenient in public places (schools, hospitals, etc.), as well as in home and school gardens, and rural marketplaces to provide greater dietary diversity and quality.
c) Design and implement policies and regulations that improve the built environment to promote nutritious food, including zoning regulations and tax regimes to minimize food deserts and swamps.
d) Regulate health claims on food packaging and adopt a front labelling system that is easy to interpret.
e) Strengthen national food safety standards and quality assurance and develop better global surveillance systems for real-time information.
f) Phase-out advertising and promotion of unhealthy foods, especially to children and adolescents.
g) Institute policies and practices that implement the International Code of Marketing of Breast-milk Substitutes.

10. CREATE CONSUMER DEMAND FOR NUTRITIOUS FOOD

States and IGOs, with the support of the private sector and CSOs should:

a) Develop global and national guidelines for healthy and sustainable diets and determine ways to make guidelines actionable and user-friendly for consumers.
b) Implement economic and social policies that increase demand for nutritious foods and lower demand for nutrient-poor foods, such as establishing evidenced-based tax policies on foods of differing nutritional value.
c) Ensure that social protection programmes such as school feeding and cash transfers lead to improved nutritional outcomes.
d) Promote food cultures, including cooking skills and the importance of food in cultural heritage, as a vehicle to promote nutrition literacy.

INTRODUCTION

Every human being has the right to adequate food. The progressive realization of this right around the world cannot be achieved without functional, sustainable food systems that ensure food security and nutrition (FSN) for all now and in the future, and that provide food that is healthy, of sufficient quality and quantity, affordable, safe and culturally acceptable.

However, malnutrition in all its forms (undernutrition, micronutrient deficiencies, overweight and obesity) still affects every country on the planet and is a major impediment to achieving both global food security and adequate nutrition, and sustainable development. Urgent actions are needed, delivered via bold policies, initiatives and investments. Currently around 0.8 billion people are still hungry, more than 2 billion are deficient in essential vitamins or minerals, and around 1.9 billion adults experience overweight and obesity. While hunger have declined over the past decades, overweight and obesity are rapidly increasing all over the world, including in low- and middle-income countries (LMICs) and, therefore, should not be overlooked.

All forms of malnutrition are the result of poor diets, inadequate knowledge and resources, and unhealthy environments, all of which have underlying causes. Food systems influence the types of food produced and the nature of their journey from farm to fork. The failure to make food systems deliver better nutrition while at the same time minimizing their environmental impact is costly. The human health, economic, social and environmental consequences of malnutrition are crippling. Around 45 percent of all children under five years mortality is related to undernutrition. The economic costs of malnutrition are high and the burdens created by malnutrition are transmitted across generations, because malnourished mothers are more likely to give birth to malnourished babies, who are in turn more likely to grow up to be malnourished adults. The global food systems of today, with their industrial-scale production and excessive consumption and waste, are not sustainable, producing significant environmental degradation and pollution, and causing extensive damage to natural systems. A new, collective and integrated approach to stewarding the planet's natural resources is imperative.

If current trends continue, the costs generated by the current collective mismanagement of the world's natural resources and food systems will rise, and the effects of these increases will be felt most strongly in the LMICs that are grappling with new forms of malnutrition while the old forms have not yet disappeared. This overlap of burdens is already occurring: 44 percent of countries for which data are available show simultaneous and serious levels of undernutrition and overweight/obesity (IFPRI, 2016). As this report shows, there are choices that policy-makers and other stakeholders can make to change this picture. These have the potential to accelerate the pace at which undernutrition is being reduced and slow down the pace at which overweight and obesity are increasing – and they can even begin to reverse these two trends.

With urbanization, incomes growth and the food industry consolidation and globalization, the length of food supply chains has increased, and food environments have become more complex. This trend provides many opportunities to enhance or diminish the nutritional value of foods. Similarly, as the food industry responds to increased purchasing power, market concentration and financial deregulation, many opportunities are being generated for enhancing or reducing the nutritional value of foods.

Acting to change systems is never easy. Vested interests, technical challenges and human and financial resource constraints all have to be overcome. Effort and focus need to be sustained. Decision-makers in the public and private sectors have an obligation and a responsibility to act, and they should feel empowered to do so. Right now, the political momentum is with those who aim to shape their food system towards improved nutrition. The Sustainable Development Goals (SDGs) – the world's main accountability tool for sustainable development over the coming 15 years – have a lot to say about food security, nutrition, climate, sustainable consumption and human dignity.

Carrying out superficial repairs to our existing food systems will no longer suffice. We need disruptive change within and across today's varied and complex food systems. To be sustainable, food system policy choices must focus on environmental as well as nutritional and health consequences. Different foods require different inputs (e.g. energy, water, fertilizers, infrastructure) to be grown, harvested, processed, stored, transported, traded, marketed and retailed. Food systems also generate varying levels of greenhouse gas (GHG) emissions. As far as the evidence allows, decision-makers need to know and consider all the nutritional, health, social, economic and environmental consequences of

the food system decisions they take. The short-term costs of the actions outlined in this report may seem high, but the cost of inaction is much higher, carrying with it a terrible legacy affecting future generations.

In this context, the UN Decade of Action on Nutrition, launched in April 2016, is heavily focused on food systems, and a plethora of reports from a wide range of bodies have made the case for food systems that are more nutrition-focused and environmentally-friendly. A FAO/World Health Organization (WHO) symposium in December of 2016 reinforced the urgency of leveraging food systems for improved FSN. This symposium noted that most prior reports on food systems fall short of outlining specific food system actions that policy-makers could implement and what they might expect to see as a consequence of implementation. This resulted in a work plan outlining what could be concretely achieved over the decade, which serves as a clock for those working in FSN to take action at different levels.

At its 42nd session in October 2015, the Committee on World Food Security (CFS) requested the High Level Panel of Experts on Food Security and Nutrition (HLPE) to prepare a report on *Nutrition and Food Systems*, to be presented at CFS 44 in October 2017. This report draws on the previous HLPE reports, many of which are highly relevant to various aspects of food systems (including the reports on sustainable agriculture and livestock, fisheries and aquaculture, sustainable forestry, and food losses and waste). This report aims to help CFS members and participants to act boldly and decisively to make the world's food systems more nutrition-promoting in a sustainable manner.

Specifically, this report presents the evidence base for CFS policy convergence work on nutrition beyond 2017, building on the political momentum from the right to adequate food, the International Conference on Nutrition (ICN2) in 2014, the UN Decade of Action for Nutrition, the SDGs and other political agendas attempting to improve nutrition through sustainable development. Most importantly, the report will provide guidance on which policy and programme actions to take in specific malnutrition contexts, and the environmental synergies and trade-offs of doing so.

The purpose of this report is two-fold: (i) to analyse how food systems influence people's dietary patterns and nutritional outcomes; and (ii) to highlight effective policies and programmes that have the potential to shape food systems, contribute to improved nutrition and ensure that food is produced, distributed and consumed in a sustainable manner that protects the right to adequate food for all.

This report identifies and analyses three core components of food systems: food supply chains, food environments and consumer behaviour. While food systems are critical, they alone will not fully solve the multiple burdens of malnutrition. To provide maximum benefit for the global population, policies and programmes must be coordinated across multiple sectors, including for instance agriculture, food industry, trade, environment, energy, health, water and sanitation, education, social protection, gender equity and women's empowerment.

The report begins by outlining the overall approach taken, as well as the conceptual framework of food systems and how these shape diets and nutrition. The second chapter briefly describes the multiple burdens of malnutrition and their health and socio-economic consequences. The third chapter examines how diets are changing and what future diets could potentially look like. The fourth chapter examines the drivers of food system changes. The fifth chapter identifies the evidence and best practices emerging from existing policies and programmes related to food systems, diets and nutrition. The last chapter attempts to draw ways forward for translating evidence into action. Short case studies illustrate the wide variety of practical experiences in different contexts. The report also provides a set of action-oriented *recommendations* addressed to states and other stakeholders in order to inform *CFS engagement in advancing nutrition* and the CFS contribution to the UN Decade of Action on Nutrition (2016–2025).

1 SETTING THE STAGE: APPROACH AND CONCEPTUAL FRAMEWORK

All people have a right to adequate food that not only meets the minimum requirements for survival but is also nutritionally adequate for health and well-being (UN General Assembly, 2012). The conceptual framework and overall approach taken in this report are guided by the overall objective to contribute to the progressive realization of this right.

The focus on nutrition and diets in this report echoes similar calls to action by several international global goal setting agendas, including the United Nations Zero Hunger Challenge, the United Nations Decade of Action on Nutrition and the SDGs. Reorienting food systems to better support nutrition will be essential to meet – among other SDGs – goal 2 (zero hunger) and goal 3 (good health and well-being).

Many recent reports highlight the need for a holistic approach and radical transformation of agriculture and food systems to tackle the multiple burdens of malnutrition and contribute to the achievement of the 2030 Agenda (Whitmee *et al.*, 2015; HLPE, 2016; IPES-Food, 2016; GloPan, 2016a; Haddad *et al.,* 2016). In FAO's 2017 report *The future of food and agriculture*, which outlined the stark trends and challenges that will influence food and agriculture in the coming decades, the Director-General of the Food and Agriculture Organization of the United Nations (FAO), José Graziano da Silva, wrote that "transformative changes in agriculture and food systems are required worldwide" if we are to mobilize concrete and concerted actions (FAO, 2017a).

The overarching challenge for agriculture and food systems is to meet the increasing and evolving dietary needs of a growing population in a sustainable way, in the context of climate change and increased pressure on natural resources, paying specific attention to the rights and needs of the more vulnerable groups (HLPE, 2016, 2017). Piecemeal action will not suffice: the world's food systems require a comprehensive overhaul.

In this context, this report aims to build a common understanding of the importance of food systems for food security, diets and nutrition. This first chapter provides an overview of the conceptual framework used in this report, offers a description of the constituent elements of food systems and food environments, gives a definition of healthy diets, describes the main outcomes of food systems and suggests a food system typology to be used for the purposes of this report.

1.1 Definitions and overview of the conceptual framework

In its report on food losses and waste, the HLPE adopted the following definition of a food system: "a *food system* gathers all the elements (environment, people, inputs, processes, infrastructures, institutions, etc.) and activities that relate to the production, processing, distribution, preparation and consumption of food, and the output of these activities, including socio-economic and environmental outcomes" (HLPE, 2014a).

The HLPE consistently considers FSN not only as an outcome but also as an enabling condition of sustainability. It defines a *sustainable food system* as "a food system that ensures food security and nutrition for all in such a way that the economic, social and environmental bases to generate food security and nutrition of future generations are not compromised". Positioning FSN as a central priority to assess the sustainability of food systems will contribute to breaking the vicious circle created by malnutrition and diseases across generations and will help policy-makers translate evidence into action. Achieving FSN should never be considered as a trade-off variable (HLPE, 2014a). Therefore, this report will examine how existing food systems influence consumer choices and diets, thus impacting nutrition and health; and how adequate consumer food choices could, in turn, shape more sustainable food systems.

Figure 1 and the following sections illustrate the conceptual framework used in this report and detail the constituent elements of food systems. Food systems, their drivers, actors and elements do not exist in isolation but interact with one another and with other systems (such as health, energy and transportation systems). These systems are interlinked and in continual adaptive cycles of growth, restructuring and renewal (Gunderson and Holling, 2001). More than food system constituents themselves, this framework underlines these interactions as they determine the complex links between food systems and their final outcomes (Neff *et al.,* 2011).

This framework has been adapted from previous reports (GloPan, 2016a; Ingram, 2011; Lawrence *et al.*, 2015; Pinstrup-Andersen and Watson 2011; Sobal *et al.,* 1998a); however, it offers three significant additions:

- it highlights the central role of the food environment in facilitating nutritious, healthy and sustainable consumer food choices (see section 1.2);
- it emphasizes the role of diets as a core link between food systems and their nutrition and health outcomes (see section 1.3); and
- it takes into account the impacts of agriculture and food systems on sustainability in its three dimensions (economic, social and environmental) (see section 1.3).

1.2 The constituent elements of food systems

The conceptual framework proposed for this report and illustrated in **Figure 1** identifies five main categories of drivers of food system changes: biophysical and environmental; innovation, technology and infrastructure; political and economic; socio-cultural; and demographic drivers (Ingram, 2011).

Biophysical and environmental drivers include natural resource and ecosystem services, and climate change. Political and economic drivers include leadership, globalization, foreign investment and trade, food policies, land tenure, food prices and volatility, conflicts and humanitarian crises. Socio-cultural drivers include culture, religion, rituals, social traditions and women's empowerment. Finally, demographic drivers include population growth, changing age distribution, urbanization, migration and forced displacement. The relative impact of each driver will depend on the type of food system in question, the type of actors involved, and the type of actions and policies that are decided upon (Nesheim *et al.,* 2015). These drivers are discussed in more detail in Chapter 4.

This section will focus on the three core constituent elements of food systems as identified in the conceptual framework: food supply chains, food environments and consumer behaviour. These elements, which are influenced by the drivers, shape diets and determine the final nutrition, health, economic and social outcomes of food systems.

1.2.1 Food supply chains

The *food supply chain* consists of the activities and actors that take food from production to consumption and to the disposal of its waste (Hawkes and Ruel, 2012). The steps of the food supply chain include: production; storage and distribution; processing and packaging; retail and markets (**Figure 1**).

At each step, food supply chains involve many large- to small-scale actors, both public and private, that are influenced by the aforementioned drivers (Porter and Millar, 1985).

The decisions made by one group of actors at one stage of the chain have implications for the others (HLPE, 2014a). These decisions influence the way food is produced and processed along the supply chain (Downs and Fanzo, 2016) and impact the four dimensions of FSN (availability; access, whether physical or economic; utilization; and stability), as well as the nutritional value of the food produced and processed.

Food supply chains can increase the nutritional value of food, by increasing access to macronutrients as well as micronutrients, for instance through biofortification, food fortification or improved storage of perishable foods (such as fruits and vegetables), or by reducing, in food formulation, the levels of substances associated with diet-related non-communicable diseases (NCDs) (e.g. trans fat, high levels of sodium). However, the nutritional value of food can also diminish along the food supply chain (e.g. in the case of food losses and contamination). This section briefly reviews each stage of the food supply chain from a nutrition and diet perspective.

Production systems

Agriculture and food production systems affect food availability and affordability (FAO, 2016a) as well as dietary quality and diversity (IBRD/World Bank, 2007a; HLPE, 2016, 2017). While nutrition can enter the food supply as food moves along the chain, the different types and varieties of foods available, as well as where and how they are produced and collected, can significantly shape diets, particularly for those who consume the food that they themselves produce.

Historically, agriculture investments in food production systems and associated research and development (R&D) tend to prioritize staple crops and oilseeds (GloPan, 2016a) over other crops, often referred to as "orphan crops", of potential nutritional and economic importance, especially for smallholders (including: cereals such as sorghum and millet; roots and tubers such as sweet potato; pulses including cowpea, common bean, chickpea, pigeon pea and groundnut; and traditional leafy green vegetables) (HLPE, 2016). As a result, although there are at least 7 000 edible plant species that have been used and cultivated as significant food sources at some point in time (Kahane *et al.,* 2013), six crops dominate what is grown on the planet: maize, rice, wheat, sugar cane, soybeans and oil palm with national food supplies becoming increasingly similar in composition (Khoury *et al.*, 2014). Of those, maize, wheat and rice represent over half of the global food supply (including human food, feed and other uses) from vegetal products (in kcal/capita/day) (FAOSTAT, 2017).[5] At the same time, more and more countries far exceed the recommended energy intake per capita, yet supplies of micronutrients in the food supply have fallen (Beal *et al.,* 2017).

The HLPE reports on sustainable agriculture (2016) and forests (2017) call for more diverse and integrated production systems at different scales, from farm, community, landscape and even broader levels, in order to strengthen food systems' resilience to external shocks (including climate variability, natural disasters or economic shocks) and contribute to dietary quality and diversity through a more diverse food supply (FAO, 2016a; Herrero *et al.*, 2017; Jones *et al.*, 2016).

Storage and distribution

Food that is not immediately consumed by the producers themselves must be stored for their later consumption or distributed. At this stage of the food supply chain, food safety and food quality losses and waste (FQLW) have a significant influence on dietary quality (HLPE, 2014a).[6] The storage and distribution of perishable foods create many opportunities for contamination and FQLW, with negative consequences for diets and health. Perishable foods such as fruits, vegetables and animal-sourced foods (ASF) (e.g. meat, fish and shellfish, eggs and dairy) are nutrient-dense,[7] but they require cold-chain storage and transport unless consumed within a short space of time and very close to their place of origin. These facilities may not be available in all areas, especially in rural areas with poor road infrastructure in some LMICs.

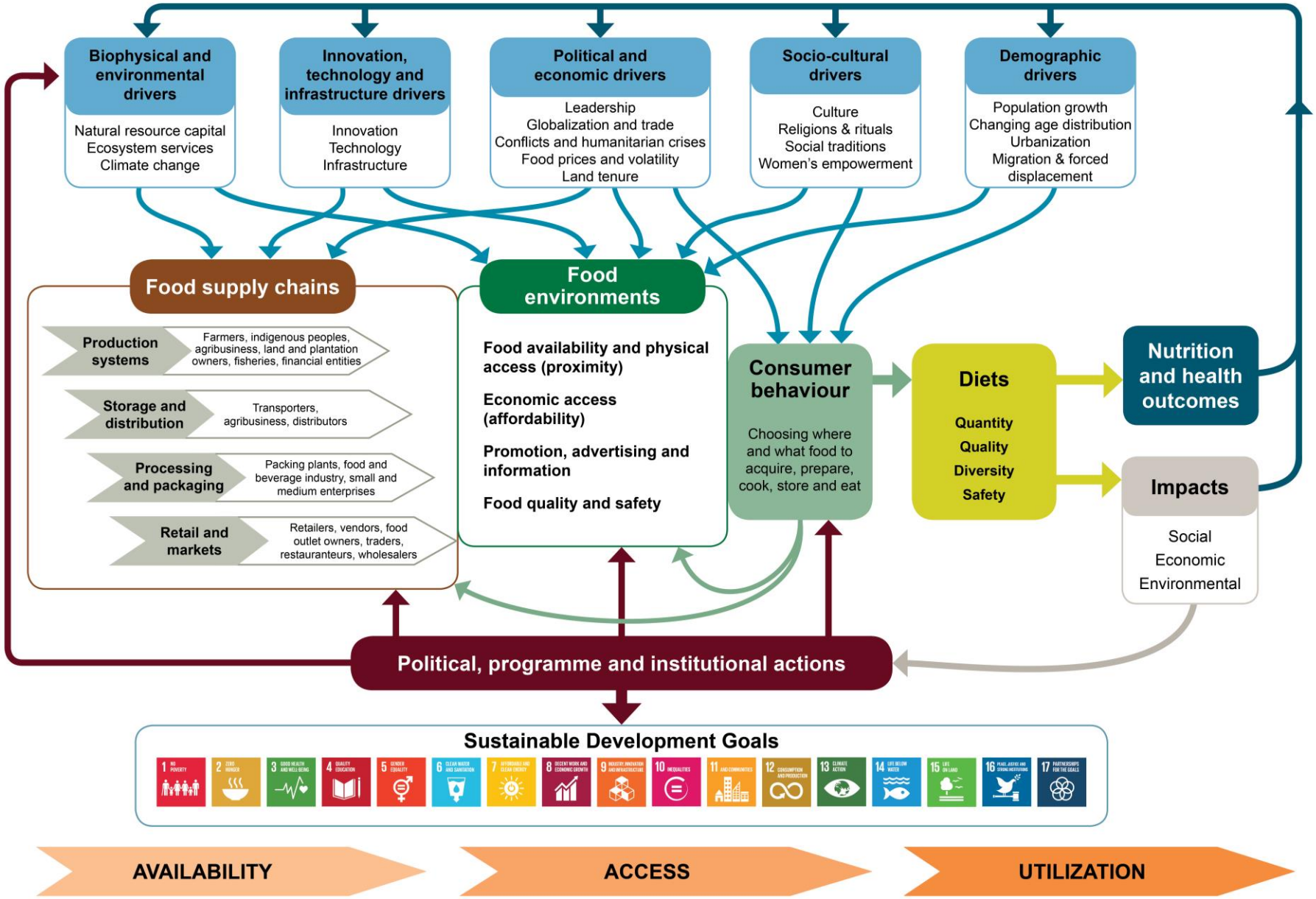
One critical food safety challenge faced by LMICs – and, to a lesser extent, by high-income countries (HICs) as well – is aflatoxin. Many staple foods can be contaminated with aflatoxin if not dried and stored properly, and this may have serious health consequences such as liver cancer but also may be linked to stunting in children (Gong *et al.*, 2002; IFPRI, 2012).

[5] Accessed 22 July 2017: http://www.fao.org/faostat/en/

[6] "Food quality losses and waste (FLQW) refers to the decrease of a quality attribute of food (nutrition, aspect, etc.) linked to the degradation of the product, at all stages of the food chain, from harvest to consumption" (HLPE, 2014a).

[7] Nutrient-dense is explained in section 1.3.1

Figure 1 Conceptual framework of food systems for diets and nutrition



Processing and packaging

Food processing and packaging contribute to FSN by preventing FQLW and extending shelf-life, by increasing the bioavailability of nutrients and improving the sensory characteristics and functional properties of foods, by destroying food-borne microbes and toxins and improving food safety (van Boekel *et al.*, 2010; Weaver *et al.*, 2014; Augustin *et al.*, 2016).

Common means of food processing include milling, cooling or freezing, smoking, heating, canning, fermentation and extrusion cooking (Augustin *et al.*, 2016). **Table 1** illustrates different categories of processed foods and examples of those foods. The extent to which food is processed may influence the degree to which nutrients enter or exit the supply chain (van Boekel *et al.,* 2010). Highly processed foods (also called "ultra-processed foods") tend to have higher amounts of saturated fat, sugar and sodium than more minimally processed foods (Poti *et al.*, 2015; Monteiro *et al.,* 2013).

Food processing can alter the nutrient content and bioavailability of foods (Augustin *et al.*, 2016), and improve their palatability and convenience (Mozaffarian, 2016). However, processing may also decrease the nutritional value of food by removing fibre and key nutrients, which then need to be added back into the foods (Mozaffarian, 2016), or by adding ingredients that normally should be limited for health reasons, including unnecessary high levels of sodium and sugar and unhealthy fats such as trans fats (Weaver *et al.*, 2014; Augustin *et al.*, 2016).

Table 1 Classification by degree of processing of food and beverage products

Category	Definition	Examples
Unprocessed/ minimally processed	Single foods, no or very slight modifications	Fresh or frozen produce, milk, eggs, fresh meat, fresh fish.
Basically processed	Single foods, processed as isolated food components or modified by preservation methods	Sugar, oil, flour, pasta, white rice, unsweetened canned fruit, unsalted canned vegetables.
Moderately processed	Single foods with addition of flavour additives	Salted nuts, fruit canned in syrup, vegetables canned with added salt, whole-grain breads or cereals with no added sugar.
Highly processed	Multi-ingredient, industrially formulated mixtures	Pre-prepared mixed dishes, refined-grain breads, ready-to-eat cereals, salty snacks, cookies, candy, sugar sweetened beverages (SSBs), ketchup, margarine, mayonnaise

Source: Adapted from Poti *et al.* (2015), Moubarac *et al.* (2014).

Retail and markets

Once food has been processed, it moves to formal or informal[8] markets that may be near to or distant from communities and households (Argenti *et al*., 2003). These markets and the retail of selling food, shape the food environment in which consumers make purchasing decisions. The HLPE report on sustainable agriculture (2016) described the radical transformation of agriculture and food systems over the past decades, driven by globalization, trade liberalization, urbanization, increase in incomes and changes in lifestyles. Those transformations as well as the need to feed huge cities, meeting growing and evolving urban dietary needs, will shape in the coming decades agriculture and food supply chains, in particular in the organization of distribution, retail and markets (FAO, 2017a: IFPRI, 2017).

The rapid spread of more formal supermarkets and fast food chains influences consumer behaviour and food consumption patterns (Reardon *et al*., 2003; Timmer, 2009). There is evidence that this so-called "supermarket revolution" (Reardon and Timmer, 2007, 2008), while offering consumers a wider

[8] Informal markets have specific characteristics such as: absence of specialization; very low capital investment; interlinkage between production and consumption; absence of bank accounts and the non-payment of all or some taxation; predominance of households and micro-enterprises with varying and limited purchasing power; importance of virtually free labour in the form of apprentice help or family members who are fed but receive no or little pay; relationships with the rural sector that often enable the provision of raw materials at lower cost.

range of products at a lower price than traditional retailers, also entails rapid organizational changes in the whole food supply chain. Small farmers are particularly challenged to meet the requirements and standards of supermarket chains, their centralized procurement systems and large-scale agro-processors in terms of volume, cost, safety, quality and consistency.

This revolution also impacts power relationships within food supply chains (Reardon and Timmer, 2008; Lang and Barling, 2012). The locus of power and decision-making is moving from farmers and producers to traders and retailers, and from governments to the private sector and multi-national corporations. Therefore, food supply chains and food systems now need complex and multi-scale governance mechanisms, which should involve a range of actors across public, private and civil society (Lang *et al.,* 2009; Biénabe *et al*., 2017).

1.2.2 Food environments

Food environment refers to the physical, economic, political and socio-cultural surroundings, opportunities and conditions that create everyday prompts, shaping people's dietary preferences and choices as well as nutritional status (Swinburn *et al.,* 2014; GloPan, 2017). It serves as an interface that mediates the acquisition of foods by people within the wider food system. For many communities, the food environment consists of the foods they produce and those they purchase from their local markets. For others, the food environment is more global, with increasingly interconnected local, regional and international markets (Hawkes, 2006). For the purpose of this report, the following definition of food environment is used:

Definition 1 Food environment

Food environment refers to the physical, economic, political and socio-cultural context in which consumers engage with the food system to make their decisions about acquiring, preparing and consuming food.

The *food environment* consists of:

- "food entry points" or the physical spaces where food is purchased or obtained;[9]
- features and infrastructures of the built environment[10] that allow consumers to access these spaces;
- personal determinants of consumer food choices (including income, education, values, skills etc.); and
- surrounding political, social and cultural norms that underlie these interactions.

The key elements of the food environment that influence consumer food choices, food acceptability[11] and diets are: physical and economic access to food (proximity and affordability); food promotion, advertising and information; and food quality and safety (Caspi *et al.,* 2012; Swinburn *et al.,* 2014; Hawkes *et al.*, 2015).

The food environment is changing how people access, prepare and consume food (Herforth and Ahmed, 2015; Mozaffarian, 2016). Half a century ago, most food was grown for household food consumption by smallholders living in rural areas. Food was also purchased at small, local markets. Now, a higher proportion of food purchased by consumers has travelled much longer distances. Supermarkets have established themselves in many different areas, with Asia and Latin American markets growing exponentially (Minten and Reardon, 2008).

Healthy food environments enable consumers to make nutritious food choices with the potential to improve diets and reduce the burden of malnutrition. However, at the same time, food environments in many parts of world are considered "unhealthy" in that they promote unhealthy dietary choices for consumers through misleading marketing and advertising, unhealthy food product placements, pricing

[9] Including, for instance: vending machines, small kiosks, *bodegas*, corner stores, wet markets and supermarkets, restaurant foraging, production for self-consumption, urban gardens, food banks, formal and informal markets, schools, hospital and public canteens (Herforth and Ahmed, 2015).

[10] The human-made surroundings and infrastructure that provide the setting for human activity, in which people live and work on a day-to-day basis.

[11] Acceptability refers to people's attitudes about attributes of their local food environment and whether the given supply of products meets their personal standards (Caspi *et al.*, 2012).

policies and packaging. Some argue that traditional, healthy food environments are being converted to ones that are convenient, but largely consist of a plethora of energy-rich, nutrient-poor foods that make it difficult for people to make healthy choices. This displacement is thought to be one reason for the increased incidence of obesity and NCDs (Baker and Friel, 2014; Malik *et al.,* 2013; Moodie *et al.,* 2013; PAHO/WHO, 2015; Monteiro and Cannon, 2012).

Availability and physical access (proximity)

Food availability, i.e. the adequate supply of food at the national or international levels, does not in itself guarantee FSN at community or household levels. Lack of access to food – in the dual sense of physical as well as economic access – can increase the risk of undernourishment as well as of obesity and diet-related NCDs, depending on the context (Duran *et al.*, 2015; Feng *et al.*, 2010; Holsten, 2009; Glanz *et al.,* 2005).

Physical access to food depends first on the built environment (presence of food entry points and adequate infrastructures to access them). Geographic or technical conditions (natural or artificial physical environments) in landlocked or small island countries, as well as the lack of appropriate infrastructure in some LMICs, can limit access to and distribution of foods, especially perishable foods. However, even in HICs, some areas can qualify as *food deserts*[12] or *food swamps.*[13] There is evidence from some HICs that food deserts with fewer supermarkets, food swamps and less access to fresh produce and minimally processed foods are often found in low-income, underserved areas (Walker *et al.,* 2010; Rose *et al.,* 2010).

However, the same built environment offers different levels of access to different consumers depending on factors that impact their own capacity to interact with this built environment, such as:

- mobility: distance to the food entry points and available means of transportation (whether private or public);
- health and disability conditions;
- purchasing power to buy nutritious foods;
- time available, kitchen facilities and equipment necessary to cook; and
- knowledge and skills to prepare and use the food accessible within the environment.

The lack of availability of a given food affects dietary choices (Herforth and Ahmed, 2015). The association between the availability and consumption of food is bi-directional, with one influencing the other (Herforth and Ahmed, 2015). Studies that have examined the role of food availability in shaping dietary intake have found a consistent positive relationship between the availability of healthy food and its consumption (Caspi *et al.*, 2012).

Economic access (affordability)

Economic access to food (food affordability) reflects the relative cost of food compared with a household's income and purchasing power (Powel *et al.,* 2013). People in LMICs tend to spend a greater proportion of their household budget on food, with people in Cameroon and Kenya spending almost half their budgets and people in Nigeria spending even more, as shown in **Figure 2**.

While relative food expenditures in HICs tend to be much lower, there is a lot of variation within countries and low-income households tend to spend a greater proportion of their income on food. While the average household in the United States of America only spent 6.4 percent of their budget on food,[14] the poorest 20 percent of households spent around 35 percent.[15] For the most vulnerable in LMICs and HICs, affording nutrient-rich foods such as ASF, fruits and vegetables is a significant challenge. In Canada, for example, low-income households purchase less dairy, vegetables and fruits compared with high-income households (Kirkpatrick and Tarasuk, 2007).

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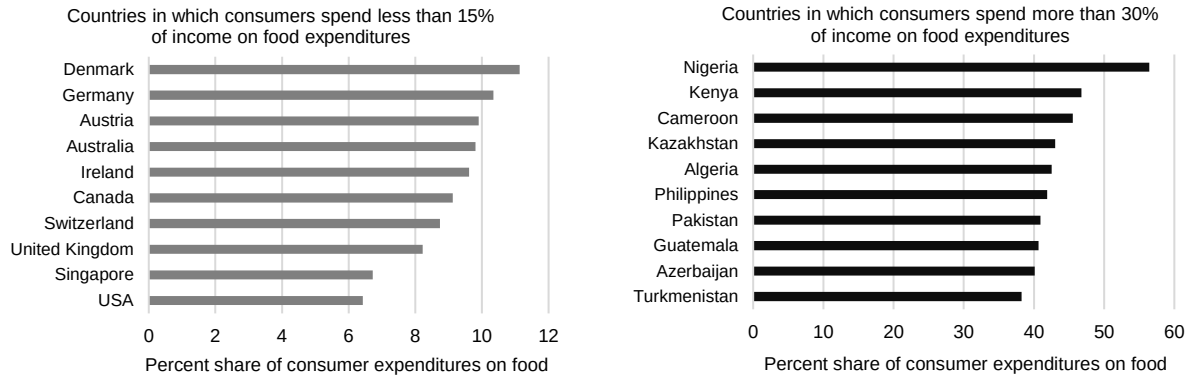
[12] Geographic areas where residents' access to food is restricted or non-existent due to the absence or low density of "food entry points" within a practical travelling distance.

[13] Areas where there is an overabundance of "unhealthy" foods but little access to "healthy" foods. For a discussion of "healthy" vs "unhealthy" foods, see section 1.3.1

[14] See: USDA ERS Food Expenditure Series 2016 "Percent of consumer expenditures spent on food, alcoholic beverages, and tobacco that were consumed at home, by selected countries, 2015" (available at: https://www.ers.usda.gov/data-products/food-expenditures.aspx)

[15] See: https://www.ers.usda.gov/data-products/chart-gallery/gallery/chart-detail/?chartId=79643 (Accessed September 2017)

Figure 2 Proportion of household budgets spent on food in different countries (2015)



Source: USDA ERS Food Expenditure Series 2016 "Percent of consumer expenditures spent on food, alcoholic beverages, and tobacco that were consumed at home, by selected countries, 2015" available at: https://www.ers.usda.gov/data-products/food-expenditures.aspx

Food prices, food taxes and subsidies affect the affordability of food and influence consumption patterns. Of course, ensuring that healthier foods are cheaper and less healthy foods are more expensive is one way to stimulate consumers to purchase certain foods over others. However, in most places in the world, this is not the case.

Both food price levels and volatility affect household purchasing power, welfare and FSN. Poor households, which spend a bigger share of their income on food as noted above, are more affected. Higher prices will reduce consumer welfare, while lower prices will impact producers. Moreover, food price volatility creates uncertainties in the whole food system, discouraging investments and thus negatively impacting FSN in the long term (HLPE, 2011a). Devereux (2009) examined the effect of seasonality on price volatility in Ghana, Namibia, Malawi and Ethiopia and highlighted the negative impact of this volatility on nutrition outcomes. In Malawi, the causal link between maize prices and child malnutrition has dramatic consequences: between October 2004 and January 2005, maize prices doubled and admissions for severe acute malnutrition (SAM) multiplied seven-fold, falling back to baseline levels when maize prices started to decrease (Devereux, 2009).

While globalization has increased the choice and year-round accessibility of many fresh foods in more affluent markets around the world, research has also shown that globalization and trade liberalization is associated with an increase in access to energy-dense processed foods of little-to-no nutritional value in urban – and in some cases, rural – areas of LMICs (de Soysa and de Soysa, 2017). Furthermore, in a number of LMICs, absolute poverty levels are high, resulting in poor economic access to nutritious food due to lack of purchasing power. As the relationships between poverty, agricultural production and FSN are complex, this difficulty may even paradoxically affect the most vulnerable people in rural areas, who experience an agricultural boom linked to the growth of a cash crop. This is the case in the Sikasso region in Mali, the cotton belt, where a deterioration of social indicators in general, and food security in particular, has been observed (Dury and Bocoum, 2012).

Promotion, advertising and information

Retail outlets and markets promote foods to consumers through various means, including advertising, branding and social marketing. Simple signage, product placement, billboards, radio and television advertisements all serve to impact food acceptability, consumer preferences, purchasing behaviour and consumption patterns, both negatively and positively (IOM, 2006; Hawkes *et al.*, 2009; Cairns *et al.*, 2013; Kelly *et al.*, 2013; PAHO, 2011).

In a systematic review conducted over the period of 2003 to 2012, Cairns *et al.* (2013) concluded that food promotion (including broadcast, print and digital advertising; packaging, labelling and point of sale promotions; branding and sponsorship; merchandising and the use of licensed or brand-based characters) has a direct influence on children's preferences, nutrition knowledge, consumption patterns and, finally, on their diets and health, and that little progress in marketing practices has been made over the same period. Another study in 13 countries, including some in South America and Asia, found that children in all countries were exposed to television advertising using child-oriented persuasive techniques to promote "unhealthy" foods such as those high in sugar and unhealthy fats (Kelly *et al.,* 2010).

The labelling of foods and the provision of declarations on food packaging, in food retail outlets and on menus, are other ways of informing consumers. Nutrition labels not only shape consumer preferences, but also influence industry behaviour by encouraging product reformulations (Cowburn and Stockley, 2005; Campos *et al.*, 2011; IOM, 2006; 2011; Cairns *et al.,* 2013). Easy-to-understand, front-of-the pack labelling and nutrition information on menus (i.e. calories or sodium content of foods) allow consumers to make more informed decisions about the foods they purchase and consume.

In addition to nutrition and food safety labels, national food-based dietary guidelines (FBDGs) are another important resource for consumers. They provide recommendations on latest evidence in hand of food and nutrient composition of healthy diets, adapted to the national context. Although they may not directly lead to changes in dietary patterns, they can influence consumer preferences and inform both actors in the food supply chain and policy-makers (FAO, 2016a; Kelly *et al.,* 2013; PAHO, 2011).

Food quality and safety

Food quality describes the attributes of a food that influence its value and that make it acceptable or desirable for the consumer (FAO/WHO, 2003). This includes: size, shape, colour, texture, flavour, food composition (ingredients and nutrients), as well as the way food is produced or processed (i.e. "organic", "cage free", "without antibiotics") (Floros *et al.,* 2010; Grunert, 2005). This includes negative attributes such as spoilage, contamination with filth, discolouration, off-odours and positive attributes such as the origin, colour, flavour, texture and processing method of the food (Giusti, *et al*., 2008).

Food safety describes the impact of food on human health, and refers to "all those hazards, whether chronic or acute, that may make food injurious to the health of the consumer"(FAO/WHO, 2003). It refers to ways to prevent food-borne diseases, arising from food contamination with pathogens or chemicals, during production, processing, storage, transport and distribution of food, as well as in the household. It also refers to the standards and controls that are in place to protect consumers from unsafe foods. Food safety and FSN are inextricably linked, with unsafe food creating a vicious circle of diseases (such as diarrhoea) and malnutrition, affecting particularly the more vulnerable (including children, the elderly and the sick) (WHO, 2015a).

There are many places in the world where food safety can be compromised as food moves through the food supply chain. Pesticide residues and certain agricultural practices can increase the risk of endocrine disruption, which multiplies the risk of certain cancers (Aktar *et al.,* 2009; Mnif *et al.,* 2011). Chronic health effects often result from prolonged ingestion of low to moderate levels of mycotoxins (including aflatoxin), pathogens produced by a wide variety of moulds mainly found during post-harvest storage. Aflatoxin, for example, has been linked to stunting (Smith *et al.*, 2015).

Lack of cold-chain storage and transport in many LMICs can render perishable foods unsafe to eat and increase the risk of pathogen transmission and attendant food-borne illnesses. Significant numbers of poor people living in rural areas or urban slums do not have access to safe food and water, and consequently suffer from diarrhoea and other diseases that contribute to malnutrition. There are also emerging issues with overuse of antibiotics in livestock systems and significant fears of antibiotic resistance and superbugs within the food supply that may put humans at serious risk (HLPE, 2016).

Food quality and safety can influence consumption patterns through changes either in consumer preferences or in food affordability. Food safety scares and crises can have an especially large impact on consumer purchases (FAO, 2016a). However, the distinction between quality and safety has implications for public policy and trade. This distinction also influences the nature and content of the food control system (Aung and Chang, 2014; FAO/WHO, 2003).

1.2.3 Consumer behaviour

Consumer behaviour reflects all the choices and decisions made by consumers, at the household or individual level, on what food to acquire, store, prepare, cook and eat, and on the allocation of food within the household (including gender repartition and feeding of children).

Consumer behaviour is clearly influenced by personal preferences, determined by a variety of interpersonal and personal factors including, but not limited to, taste, convenience, values, traditions, culture and beliefs (Glanz *et al.,* 1998; Sobal and Bisogni, 2009). However, behaviour is largely shaped by the existing food environment, which includes, as shown in the previous section, personal and collective determinants of consumer food choices (including food prices, income, knowledge and skills, time and equipment, and social and cultural norms).

Therefore, the processes whereby food is selected, purchased, prepared and presented for consumption vary across regions, countries and cultures, but also across communities, households and individuals. Many people lack the culinary skills to obtain the best nutritional outcomes from the food available to them, even if its constituent elements are nutritious. Convenience foods that require little-to-no preparation may well be preferred in such instances, although they may be far less nutritious than home-cooked food. Cost is also a key concern, and some consumers may be more likely to purchase lower-cost foods purely for budgetary reasons. Others, by contrast, are able to actively consider health, animal welfare or the environment when making food choices.

Collective changes in consumer behaviour can open a pathway towards more sustainable food systems. Consumer behaviour can be changed through interventions aimed at the food environment known as "choice architecture" (Hollands *et al.*, 2013) or through "agentic" interventions,[16] such as incentives, education programmes or FBDGs, to provide more information to consumers. Agentic interventions promoting healthy eating have been shown to reduce social inequalities in diets in LMICs (Mayén *et al.*, 2016).

Dynamic processes and influences during a person's lifetime shape food choices. These processes are moulded by life events and experiences and dictate how people interact with their food environment and guide a person's eating behaviour. Consumers consistently negotiate and balance food choice values, classify foods and form routines for recurring food decisions. Personal food environments and their influences are immediately proximate to food behaviour, although life experiences and influences also shape behaviour less directly. Life experiences and influences are in turn affected by food behaviour, as people's food choices define their identity as well as their nutritional status and health (Sobal and Bisogni, 2009).

Consumers face many barriers to healthy eating, and the way that they interact with food is affected not only by their own beliefs and decisions but also by the people in their lives, their community and environment and the culture in which they live.

1.3 Diets

Diets comprise the individual foods that a person consumes and dietary patterns are the quantities, proportions, and combinations of different foods and beverages in diets and the frequency of how they are habitually consumed (Hu, 2002). Dietary patterns interact with food systems, not only as an outcome of existing food systems but also as a driver of change for future food systems. This section discusses healthy and sustainable diets, as well as the concepts of "healthy" vs "unhealthy" food, and briefly presents the main health, environment, economic and socio-cultural outcomes of diets.

1.3.1 Healthy and sustainable diets

Diets should meet energy needs, provide a diversity of foods of high nutritional quality and be safe to consume. Such diets should be affordable, accessible and culturally appropriate. There is no single, universal and "ideal" diet, and diets are often adapted to local contexts and cultures. However, some basic principles can be applied to help define "healthy" diets. The ICN2 Rome Declaration states that "nutrition improvement requires healthy, balanced, diversified diets, including traditional diets where appropriate, meeting nutrient requirements of all age groups and all groups with special nutrition needs, while avoiding the excessive intake of saturated fat, sugars and salt/sodium, and virtually eliminating trans fats, among others" (FAO/WHO, 2014).

According to WHO, "the exact make-up of a diversified, balanced and healthy diet will vary depending on individual needs (e.g. age, gender, lifestyle and degree of physical activity), cultural context, locally available foods and dietary customs" (WHO, 2015b). Healthy diets typically have the following characteristics:

- **Quantity:** Healthy diets contain adequate food energy to maintain life, support physical activity and achieve and maintain a healthy body weight; sufficient macro- and micronutrients to meet individual nutrition and health needs. They limit overconsumption, particularly of nutrient-poor foods high in energy, saturated and trans fats, added sugars and salt.

[16] In social sciences, the term "agency" refers to the personal capacity of individuals or communities to make their own choices independently. It is opposed to "structure", which designates the socio-structural patterns that impact or limit those individual choices and opportunities.

- **Diversity:** Healthy diets include a variety of nutrient-dense foods from basic food groupings including vegetables, fruits, whole grains and cereals, dairy foods and animal- and plant-based protein foods. Specific types and amounts of foods within these groups, especially staple foods, will vary depending on geographic location and cultural context.
- **Quality:** Healthy diets contain the needed macro- and micronutrients. Foods should not contain unspecified or unhealthy additives such as trans fats. Foods can also be processed to remove "anti-nutrients" or components within foods that interfere with the absorption of key nutrients (i.e. phytates or oxalates that inhibit iron and zinc absorption) (De Pee and Bloem, 2009).
- **Safety:** Healthy diets contain foods and beverages that are safe to consume.

WHO (2015b) and other authors (Korat *et al.,* 2014; Malik *et al.,* 2013; Mozaffarian, 2016), recommend the following principles to elaborate "healthy" diets (for adults), preventing malnutrition in all its forms, as well as NCDs:

- Increase intake of fruits, vegetables, legumes (e.g. lentils, beans), nuts and whole grains (e.g. unprocessed maize, millet, oats, brown rice).
- Consume ASF (dairy, meat, eggs, fish and shellfish, etc.) in moderation, and limit processed meats.
- Decrease intake of refined sugars that are added to foods or drinks by the manufacturer, cook or consumer, and concentrated sugars naturally present in honey, syrups, fruit drinks and fruit juice concentrates.
- Substitute unsaturated fats or vegetable oils (e.g. found in fish, avocado, nuts, sunflower, canola and olive oils) over saturated fats (e.g. found in fatty meat, butter, palm and coconut oil, cream, ghee and lard). Industrial trans fats, or partially hydrogenated oils (found in processed food, fast food, snack food, fried food, baked goods, margarines and spreads), are not part of a healthy diet.

This guidance is very similar to diets such as the Dietary Approaches to Stop Hypertension (DASH) diet,[17] based on the DASH trial, which found that eating a reduced-fat diet rich in fruits, vegetables and low-fat dairy reduced blood pressure in normotensive and hypertensive individuals (Appel *et al.,* 1997). A recent meta-analysis found healthy eating patterns associated with significantly lower blood pressure contained vegetables, fruits, whole grains, legumes, seeds, nuts, fish and low-fat dairy foods (Ndanuko *et al.,* 2016), like the DASH diet.

The idea of classifying foods as "healthy" and "unhealthy" based on their nutrient composition (Lobstein and Davies, 2008) is still debated, and there is no general consensus in labelling foods as such.[18] Some argue that no foods are inherently "healthy" or "unhealthy" and that all foods can be part of a healthy diet if consumed in moderation. More and more, there is a push to move away from nutrient-specific or food-specific approaches to more holistic approaches examining overall dietary patterns (Mozaffarian and Ludwig, 2010). However, foods make up those diets, and there is good reason to delve deeper into why specific foods are considered more or less healthy by analysing both macro- and micronutrient content as well as fibre, phytonutrients, antioxidants and other compounds.

"The concept of a nutritious food is not based on any consistent standards or criteria. In many cases, healthful foods are defined by the absence of problematic ingredients—fat, sugar, and sodium—rather than by the presence of any beneficial nutrients they might contain" (Drewnowski, 2005). One way of understanding healthy foods is to examine the nutrient density of foods – those foods that supply relatively more nutrients than calories (Drewnowski and Fulgoni, 2014). Nutrient-dense foods are those that raise the amount of nutrients (such as vitamins and minerals) relative to their caloric content. For example, if two foods contain the same number of calories, a nutrient-dense food would provide high levels of vitamin A, iron or calcium. Nutrient density considers the presence of micronutrients, not just the energy yielding from macronutrients for optimal health. Nutrient density can distinguish between diets that are energy-dense, nutrient-poor or nutrient-rich (i.e. healthier

[17] See: http://dashdiet.org/default.asp (accessed July 2017)

[18] For example, in the United States of America, the Food and Drug Administration (FDA) has started a public process to redefine the "healthy" nutrient content claim for food labelling. https://www.fda.gov/food/guidanceregulation/guidancedocumentsregulatoryinformation/labelingnutrition/ucm520695.htm

options) but may not necessarily help consumers towards options that have lower cost or higher enjoyment (Mobley *et al.,* 2009; Drewnowski, 2005).

In recent years, efforts have been made to define diets that are both healthy and sustainable. However, many gaps remain in our understanding of how to achieve sustainable diets for all (Johnston *et al.*, 2014; Jones and Ejeta, 2016), According to Berry *et al.* (2015), without integrating sustainability as an explicit dimension of food security, today's policies and programmes could become the very cause of increased food insecurity in the future.

In line with the HLPE definition of sustainable food systems (HLPE, 2014a), and as consistently evidenced in previous HLPE reports (including HLPE 2016 and 2017), FSN and human health should be considered as key outcomes and enabling conditions for sustainability. In the long term, there will be no food security or health without sustainability and no sustainability without food security and health. Therefore, this report adopts the following definition for *sustainable diets*, endorsed by the participants of the International Scientific Symposium "Biodiversity and Sustainable Diets: United Against Hunger" co-organized by FAO and Bioversity International in November 2010 in Rome.

Definition 2 Sustainable diets

"Sustainable diets are those with low environmental impacts which contribute to food and nutrition security and to healthy life for present and future generations. Sustainable diets are protective and respectful of biodiversity and ecosystems, culturally acceptable, accessible, economically fair and affordable; nutritionally adequate, safe and healthy; while optimizing natural and human resources" (FAO, 2012a).

This agreed definition recognizes the interlinkages between food production and consumption and FSN and health. In line with the "One Health" concept, it reaffirms the fact that human health cannot be isolated from ecosystem health (FAO/OIE/WHO/UN System Influenza Coordination/UNICEF/World Bank, 2008; FAO, 2012a).

1.3.2 The nutrition, health, environmental, economic and social outcomes of diets

Food systems, through diets, give rise to a variety of outcomes. These relate not only to nutrition and health, but also to all the dimensions of sustainability, which in turn link back to the food system drivers.

Nutrition and health outcomes

Healthy diets are essential to prevent malnutrition in all its forms (undernutrition, micronutrient deficiencies, overweight and obesity). These multiple burdens of malnutrition (see Chapter 2) lead to health problems such as underweight and stunting and to diet-related NCDs such as diabetes, coronary heart disease, cancer and stroke (WCRF/AICR, 2007; Hawkesworth *et al.*, 2010).

Environmental outcomes

The demand for certain diets influences water and land use, biodiversity and climate change (Senker, 2011). For instance, the HLPE (2016) report on sustainable agriculture and livestock highlighted the significant impacts on the environment, both positive and negative, of the livestock production needed to meet an increasing demand for ASF. Predominant food production and consumption practices currently place unprecedented pressures on natural resources and alter the ecosystems where people live around the world, in turn profoundly affecting their diets (MA, 2003; Tilman and Clark, 2014; Lang and Rayner, 2012).

Economic outcomes

Agriculture and food production provide income and employment for millions of people, particularly smallholders and poor people in rural areas (HLPE, 2013). Agriculture alone is estimated to provide employment to 1.3 billion people worldwide, 97 percent of them living in developing countries (IBRD/World Bank, 2007a). However, unhealthy diets and malnutrition hamper economic growth and perpetuate poverty via three main routes: direct losses in productivity from poor physical status; indirect losses from poor cognitive function and deficits in schooling; and losses owing to increased

health care costs. Consumption patterns can also have positive economic impacts, for instance through the reduction in food losses and waste (HLPE, 2014a).

Social equity outcomes

Global food production has kept up with the demands of a growing human population (Dyson, 1996), but inequities remain in the distribution of the available food (Sen, 1981; Ehlrich and Harte, 2015). More equitably distributed food would improve health for the most vulnerable and, therefore, enhance social equity, which may positively impact vulnerable groups such as those living in poverty, women, children and smallholders.

Trade-offs and unintended effects of diet changes

Although a single change in diets may bring multiple outcomes, these may not all be beneficial. A nutritional intervention may have unintended environmental, economic and social consequences. For instance:

- increasing the consumption of fish – an important source of omega 3 fatty acids, iodine and vitamins A and D – as per dietary guidelines might further deplete marine resources;
- increasing the consumption of red meat (beef), which has high iron levels, may, in certain conditions, demonstrate significant environmental impacts, including on water and land use and greenhouse gas emissions (HLPE, 2016);
- meeting increased demand for palm oil may, in certain conditions, generate deforestation and biodiversity loss (HLPE, 2017).

Therefore, even though the food system is complex, it is important to consider the synergies, trade-offs and negative effects that may result from changes in diets (Ingram, 2011).

1.4 A food system typology

Food systems exist on a continuum, and any attempt to classify food systems into discrete types should not hide the huge diversity existing within each type. Food systems can be considered at different scales (from global to local levels), and even from a household perspective. Multiple food systems co-exist simultaneously within any given country.

With those caveats, typologies are useful because they illustrate the complexity of food systems, and allow researchers and policy-makers to consider the diversity of systems when designing policies and interventions adapted to a given context (Ericksen *et al.*, 2010).

Several typologies already exist covering distinct elements of food systems. For example, the HLPE (2016) report on sustainable agriculture and livestock suggested a typology focusing on farming systems composed of four livestock production system types (smallholder mixed farming, pastoral, commercial grazing and intensive livestock systems) as well as two plant-based production system types (crop and feed producing systems, plant-based smallholder systems).

The Global Nutrition Report (GNR) (IFPRI, 2015a) identified five food system types: rural, emerging, transitioning, mixed and industrialized. According to the GNR, the transition from rural towards industrialized food systems is linked to urbanization, higher agricultural productivity, greater dietary diversity, lower reliance on food staples and lower relative household food expenditures. This GNR typology moves beyond production systems to cover the whole food supply chain and some aspects of the food environment.

Gómez and Ricketts (2013) describe four types of food value chains (traditional, modern, modern-to-traditional and traditional-to-modern) (**Table 2**). A value chain, much like a supply chain, involves the full range of activities that are required to bring a product or service from conception, through the different phases of production (involving a combination of physical transformation and the input of various producer services), delivery to final consumers, and final disposal after use (Kaplinsky and Morris, 2001). These typologies were used as a basis to elaborate the food system typology in this report.

Table 2 Typology of food value chains

Type	Description
Traditional	Traditional traders buy primarily from smallholder farmers and sell to consumers and traditional retailers in wet (mostly local) markets
Modern	Domestic and multi-national food manufacturers procure primarily from commercial farms and sell through modern supermarket outlets
Modern-to-traditional	Domestic and multi-national food manufacturers sell through the network of traditional traders and retailers (e.g. "mom and pop" shops)
Traditional-to-modern	Supermarkets and food manufacturers source food from smallholder farmers and traders

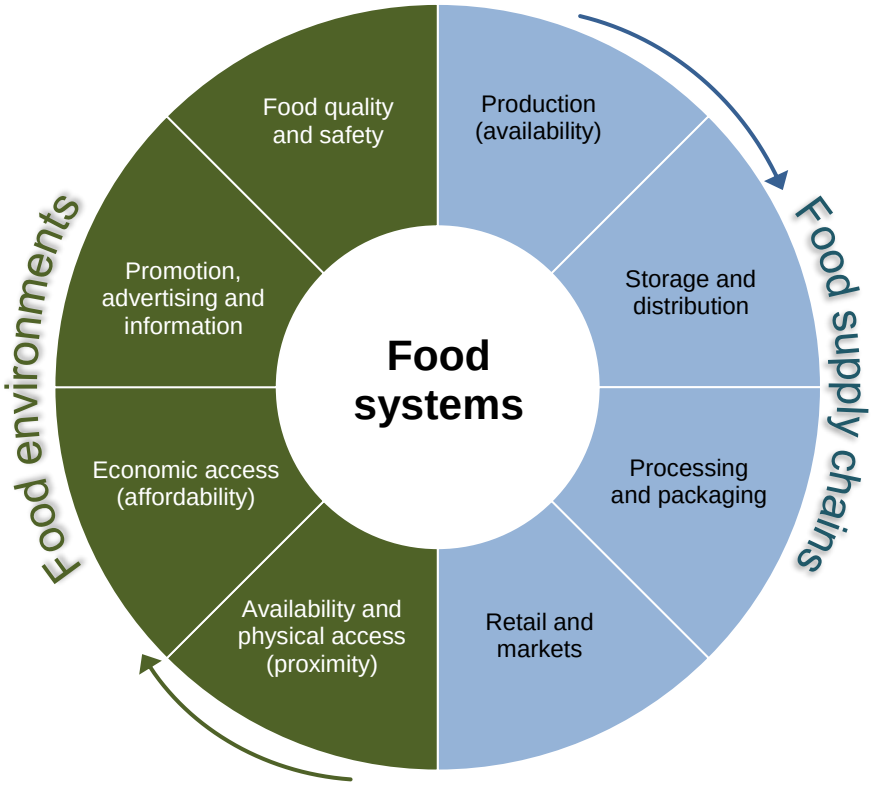
Source: Gómez and Ricketts (2013).

The typology presented in this report covers both food supply chains and food environments with the view to identify the strengths and weaknesses of each type of food system, as well as the challenges and opportunities they face, and to design context-specific pathways and recommendations.

This report identifies three broad types of food systems: (i) traditional food systems; (ii) mixed food systems; and (iii) modern food systems. The "food system wheel" (**Figure 3**) captures the different elements of the food supply chain and of the food environment, defined above, on which to act in order to enhance health and nutrition outcomes, and the sustainability of these different types of food systems. This food system wheel will structure the discussions around pathways and solutions in Chapter 5.

The two sets of four elements of the food supply chain and of the food environment are further explored across the three types of food systems (**Table 3**). It is important to note that though these types represent the food systems with which people interact, there are intra-food system differences regarding how food is allocated, the needs of different groups within those food systems, seasonality and so on. These attributes cut across food systems and connect them to nutrition and health outcomes. Each food system type is described below.

Figure 3 Food supply chains and food environments



Source: Adapted wheel concept from Ranganathan *et al.* (2016).

Table 3 Food system types and their food supply chains and food environments

Food supply chains	Traditional food systems	Mixed food systems	Modern food systems
Production (availability)	Food is mainly produced by smallholders in the area and most of the foods available are local and seasonal.	Food production takes place at both local smallholder farms and larger farms that are farther away. There is greater access to foods outside their typical season.	A wide array of foods is produced at farms ranging from small to industrial in size. Production is global, so foods are available from anywhere and at any time.
Storage and distribution	Lack of adequate roads makes transporting food difficult and slow, leading to food waste. Poor storage facilities and lack of cold storage makes storing food, especially perishables, difficult and leads to food safety concerns and waste.	There are improvements in infrastructure with better roads, storage facilities and increased access to cold storage; however, these are usually not equally accessible, especially for the rural poor.	Modern roads, storage facilities and cold storage make it easy to transport food on long distances and store it safely for long periods of time.
Processing and packaging	Basic processing is available such as drying fruit, milling flour or processing dairy. Little or limited packaging occurs.	Highly-processed packaged foods emerge and are more accessible. These extend the shelf life of foods.	Many processed packaged foods are easily available, often cheap and convenient to eat, but sometimes "unhealthy".
Retail and markets	Low diversity and density of food retail options leads to a heavy reliance on informal kiosks and wet markets.	Greater diversity of both informal and formal bodegas, corner stores and markets. More access to meals eaten outside the home including street food and fast food.	High diversity and density of "food entry points" including all of the options in the other systems as well as larger super- and hypermarkets, fast casual food and fine dining restaurants.
Food environments	**Traditional food systems**	**Mixed food systems**	**Modern food systems**
Availability and physical access (proximity)	Higher density of local informal markets but longer distances to access formal markets and poor or non-existent roads make travel difficult and long.	There is still a high density of informal markets but there is also a larger number of formal markets. Better road and vehicle access emerges, increasing consumer access to different foods. However, low-income consumers often have less access to transportation.	Reliance is on formal markets with locations in close proximity with easy accessibility. Low-income areas can often be qualified as food deserts or food swamps.
Economic access (affordability)	Food is a large portion of the household budget. Staples tend to be significantly less expensive relative to ASF, which tend to be more expensive.	Food places moderate demands on the household budget. Staples are inexpensive, whereas ASF and perishable foods are expensive. Many highly processed and convenience foods are inexpensive.	Food demands less of the household budget. The price of staples is lower relative to ASF and perishable foods, but the difference is less stark than in the other systems. With more options, specialty items (e.g. organic, locally produced) tend to be more expensive.
Promotion, advertising and information	Very little promotion, with the exception of the efforts of some multi-national companies. Posters, signs in kiosks and on buildings, some billboards. Very little information in terms of labelling and guidelines. Information disseminated largely through public health nutrition education.	Branding and advertisements become more common, including on billboards, print, radio, television and the Internet. Some information provided, and labels on food products and on the shelves of stores. Dietary guidelines available, but with little or no access in some areas.	High level of food promotion via multiple media channels. Marketing targeted to specific groups (e.g. children). High level of information on labels, shelves in stores and menus. High level of information from public health campaigns.
Food quality and safety	Low control of quality and food safety standards. Little to no cold storage. Less of a demand for quality ingredients.	Quality and food safety controls exist, but are often not adhered to. Food safety adherence is often limited to branded processed packaged foods. Cold storage exists, but is not reliable. Ingredient lists on foods but less emphasis on "natural" or "organic."	Food safety standards are closely adhered to and monitored. Cold storage is prevalent and reliable. Ingredients listed and standardized. Demand for foods and animals grown in certain ways adhering to sustainability and animal welfare practices.

1.4.1 Traditional food systems

In traditional food systems, people generally live in rural areas. Nevertheless, dietary diversity can be low partly because people rely mainly on locally grown, fished, herded, hunted or gathered foods and often lack appropriate infrastructure to access distant markets. People tend to grow much of their own food and buy food from local daily and weekly wet markets, and from kiosks. These markets primarily sell fresh foods, but may also sell some packaged foods. The kiosks sell staples, such as cooking oil and sugar, as well as packaged foods and convenience foods, such as instant noodles and snack foods. The food that is accessible tends to be affordable, but ASF are often less affordable than staples. Foods are often not monitored for quality and safety. There is also very little food promotion or information.

Many people's diets primarily consist of staple grains such as maize, rice and wheat, and do not contain sufficient amounts of protein and micronutrients. Stunting rates may therefore be high, along with the incidence of micronutrient deficiencies. These nutritional outcomes impact people's immune systems and make them more susceptible to infectious diseases, including diarrhoea and upper respiratory infections. Morbidity and mortality are much too high, especially in children under five years of age. **Box 1** describes a food environment in rural Kenya.

Box 1 A traditional food environment in rural Kenya

People in the average rural settings in Kenya depend mainly on their own production for food (Oduol, 1986). While many places grow the main staple – maize – what is available for consumption depends largely on agricultural potential, with the more productive areas providing greater diversity in food production and, hence, resulting consumption. Some foods, such as fresh vegetables, are only farmed seasonally (Alinovi *et al.,* 2010).

People in rural areas of Kenya also depend on food purchases. For instance, it is common to buy milk, eggs and vegetables from neighbours. Moreover, there is at least one kiosk in every village. These kiosks stock mainly common grocery items such as sugar, cooking oil (mostly fat) and cereal flours. The items are slightly more expensive in terms of price per unit compared with nearby trading centres or urban centres. However, since they are sold in very small units, they are generally affordable to low-income consumers. These kiosks also stock baked goods and cookies such as bread and biscuits, but it is also common to find locally-baked goods such as *mandazis* and *ngumus,* baked at nearby trading centres with little quality control. International brands, such as sodas and margarine, are also common in these kiosks (Dorosh and Babu, 2017; Eriksen *et al*., 2005).

Generally, the village kiosks offer very little choice. However, there is often a trading centre not very far away. These centres have several shops and kiosks with a greater variety of food items and brands compared to the village kiosks. For instance, they have a greater assortment of sweetened drinks apart from sodas. These shops also provide bigger packaging sizes that are relatively cheaper per unit. They expand the choice for rural consumers, but it is still limited compared to what is found in urban settings. The shops are traditional retail outlets without self-service.

In addition to the shops, the trading centres also have small wet markets or fresh-food kiosks selling fruits and vegetables, but also other commodities such as pulse grains. The varieties accessible in these centres depend mainly on the proximity to major towns with big markets or to production area, and on road conditions. These trading centres also host weekly wet markets, which involve revolving markets that are hosted on different days by different trading centres. These markets offer more choice, especially of fresh fruits and vegetables, though variety depends on the diversity of production in that region and proximity to major towns (Rischke *et al*., 2015).

Additionally, the trading centres have butcheries and restaurants, including mini-fast food joints. Though butcheries mainly sell ruminant meat, restaurants cook meals and also sell fast foods such as French fries, sausages and a large assortment of fried foods such as *mandazis* and *chapattis*. The quality of the meat is usually checked at slaughterhouses, but many other goods are unregulated. These trading centres may also have some street food points, retailing foods such as fried fish, sausages or roasted maize. Food promotion is rare, and food information is limited to sell-by-dates and listing of ingredients, mainly for major brands. Although undernutrition is still a major problem in the majority of these rural settings, NCDs such as diabetes and hypertension are becoming more common (Chege *et al*., 2015).

1.4.2 Mixed food systems

In mixed food systems, there is a higher proportion of people living in peri-urban and urban areas and having greater incomes than in traditional food systems.

The food environment offers a wider range of "food entry points". People still have access to local wet markets, but also to supermarkets that have a wide variety of processed, packaged and fresh foods all year long. However, access may be limited in low-income areas, and fresh produce and ASF are often more expensive than packaged foods. People have access to bodegas or corner stores that are similar to the kiosks in traditional food systems.

People also have more access to prepared meals eaten outside the home. Urbanization is accompanied by a rise in street food (see **Box 2**), which presents another food option in the mixed system. There is a broad spectrum of food quality and safety levels across different food sources. However, emerging regulation results in increased standardization of the quality and safety of foods. More food promotions are seen, especially in supermarkets and at fast food restaurants. The increased availability of packaged foods and food regulation also results in an increase in food labelling and other sources of food information.

In these systems, people tend to have access to diverse foods, leading to sufficient calorie and protein intakes. Both wasting and stunting in children under five are, therefore, rare. Better nutritional status, as well as advances in water provision, sanitation, hygiene and other medical services, lead to lower incidences of, and mortality from, infectious diseases. With the availability and popularity of processed foods, there is increased intake of saturated and trans fats and sugar. There is also increased consumption of ASF, which are a source of protein, but also of saturated fat. Some dietary changes result in these systems in an increasing incidence of overweight and obesity and lead to an increased incidence of, and morbidity from, NCDs such as cardiovascular disease and diabetes. While life expectancy increases due to the decrease in infectious diseases, morbidity increases due to the rise in NCDs. **Box 3** describes the increasingly urbanized food environment in India.

Box 2 The rise of street food in mixed food systems

Street foods comprise a wide range of ready-to-eat foods and beverages that are sold, and sometimes also prepared, in public places, notably streets. Like fast foods, the final preparation of street foods occurs when the customer orders the meal, which can be consumed where it has been purchased, or else taken away. Street foods and fast foods are low in cost compared with restaurant meals and offer an attractive alternative to home-cooked food. These foods make a significant contribution to nutrition. However, they also harbour the risk of food-borne illnesses on account of the potentially unsanitary conditions in which food may be stored and prepared.

In LMICs, daily energy intake from street foods in adults ranged from 13 to 50 percent of total energy intake, and up to 50 percent of protein requirements (Steyn *et al.*, 2014). In children, street foods contributed 13 to 40 percent of their daily energy needs. It was also found that many street foods contain high levels of saturated and trans fats, sugar and salt. However, street foods can also be diverse and, in South Africa, fruit is a commonly consumed street food (Mchiza *et al.*, 2014).

In Ghana, the majority of street food vendors sell cooked dishes, and mostly foods rich in protein and carbohydrates (FAO, 2016b). To a lesser extent, they sell foods that contain vegetables, and only one in eight vendors sells fruit. More than a quarter of vendors sell homemade snacks, and one in eight sells pre-packaged foods and snacks. A quarter of vendors sell beverages, whether industrial or natural. The items they sell also depend on the location. For instance, fruit tends to be sold less and pre-packaged industrial foods more in the vicinity of schools than in other places.

Box 3 The transitioning Indian urban food environment

The food environment in urban centres in India is characterized by increasing choices, including increased access to processed, packaged and ready to eat energy-dense foods. Food is mainly purchased through the informal food sector such as “mom and pop” shops (e.g. corner stores), street stalls and kiosks, wet markets and unchained fast food restaurants, including street vendors (Downs *et al.,* 2014; Euromonitor International, 2016a). These outlets are more numerous, accessible and affordable than supermarkets and chained fast food restaurants, making them more popular among consumers (Euromonitor International, 2016a). However, the food sold is often of variable quality, much of it is unbranded and does not contain labels (Downs *et al.*, 2014). Although the informal food sector in India still dominates, a shift towards modern retail is under way.

Between 2006 and 2011, there was a 20 percent increase in volume growth of chained fast food restaurants as compared with a 7.2 percent increase in independent restaurants. Over the same period of time, there was a 54 percent increase in supermarket growth in the country whereas there was a 4 percent decline in independent grocers (Euromonitor International, 2012). Coinciding with the shift towards modern retail, there has been significant growth in packaged food sales in the country (Euromonitor International, 2016b), including “better for you” packaged foods targeted at more affluent consumers with higher disposable incomes (Euromonitor International, 2016c).

Although the quality of foods available in the modern retail sector is generally high, food safety is still a concern in the country. To address this, the Food Safety and Standards Authority of India (FSSAI) has recently prompted the state and central governments to frame stringent guidelines for monitoring the food safety of products as well as to ensure that food manufacturers remove false claims and/or more fully disclose ingredients on their packaging (Euromonitor International, 2016b). Thus, there is a push to improve both the composition of packaged foods as well as the information that is given to consumers in order for them to be able to make more informed food choices.

1.4.3 Modern food systems

In modern food systems, a higher proportion of people tend to live in urban areas and have greater incomes and an overwhelming number of food choices. Consumers often live far from where their food is produced. Through technological and infrastructural advances (including distribution and exchange), a wide variety of foods is accessible to consumers all year long. Markets tend to be close to one another, and consumers have options as to where they procure their foods. Supermarkets and wet (“farmers”) markets tend to offer more choice, better quality and more specialty items. There are many options for prepared meals eaten outside the home, such as fast casual and fine dining restaurants and gourmet food trucks. These tend to use higher-quality ingredients.

As with mixed food systems, there is a wide range in food prices, with fresh produce and ASF being more expensive than most packaged foods. However, the relative cost of these commodities compared with staples is lower than in the traditional food systems. Produce that is local and organic tends to be more expensive. There are also even more expensive options, including specialty packaged foods and upscale restaurants. Strong regulations and means of implementation enable a strict control of food quality and safety. Even more food promotions and food labelling are seen, and these often have a focus on health or the environment, such as highlighting non-genetically modified (GM), local or organic products.

In modern food systems, the abundance of food, especially highly-processed food, is associated with increased risk of overweight, obesity and NCDs. However, increases in income and education are likely to make people more aware of the relationship between diet, nutrition and health. People in these systems also tend to have increased access to, and quality of, medical care, including the prevention and management of NCDs. This often leads to decreased morbidity and even longer lifespans, despite the presence of these diseases.

1.5 Conclusion

A better knowledge of food systems, and of the interactions between food supply chains, food environments and consumer behaviour, is critical to understand why and how diets are changing and influencing people's nutritional status around the globe. Such understanding is needed to identify ways of intervening and applying a rights-based approach to improve FSN for all, especially the most vulnerable.

The conceptual framework and the food system typology described illustrate the complexity and diversity of the problems and challenges faced by the world's current food systems. The food system wheel and typology suggested here is an attempt to consider this complexity when designing pathways towards more sustainable food systems that enhance FSN and health. Building on the definitions and conceptual framework provided in this chapter, the following chapter will draw a diagnosis of the current situation, describing the multiple burdens of malnutrition.

2 THE MULTIPLE BURDENS OF MALNUTRITION

Globally, one person in three today is malnourished (IFPRI, 2015a). If current trends continue, one person in two could be malnourished by 2030, in stark contrast with the objective to end hunger and all forms of malnutrition by 2030 (GloPan, 2016a). Food systems and diets are major contributors to the nutritional status of populations, and thus play an important role if the burden of malnutrition is to be successfully addressed.

Malnutrition is inadequate dietary intake relative to individuals' dietary needs. It manifests itself in multiple forms: undernutrition (dietary energy deficiency); micronutrient deficiencies; overweight and obesity (dietary energy surplus). "Dietary energy" is kilocalories from proteins, carbohydrates and fats (macronutrients). "Micronutrients" are vitamins and minerals. Both macro- and micronutrients are essential for human growth and development, and both can be influenced by changing food systems and evolving consumers' preferences.

Malnutrition, in different forms, affects every country, whether developing or developed, and presents a considerable challenge for governments. Diverse types of malnutrition can co-exist in the same country, community or household, and even at the individual level. The growing prevalence of malnutrition worldwide requires integrated approaches that address a multiplicity of burdens and that target their causes across the entirety of food systems.

This chapter outlines the current burdens of malnutrition, explains which population groups are particularly susceptible and details the health, social and economic consequences of malnutrition. This chapter also contains selected case studies that demonstrate how the malnutrition burden outcomes can be addressed and how generally, food system types relate to the burdens.

2.1 The current burdens of malnutrition

Box 4 and **Figure 4** provide some background on how the different forms of malnutrition are measured and some commonly used indicators.

Box 4 Measuring malnutrition: some commonly used indicators

Anthropometric measures, as well as blood and urine analyses are often used to measure child and adult malnutrition. Anthropometric measures of childhood malnutrition are often used to better understand the health and nutritional status of entire populations (WHO, 2010a). The most common of these proximal anthropometric measures for children are underweight, stunting, wasting and overweight (**Figure 4**).[19] *Underweight* is a composite measure representing wasting, stunting or both (WHO, 2010a), and is indicated by a child's weight being two standard deviations below normal for his or her age (as compared with the WHO Child Growth Standards).

- *Stunting* is an indicator of chronic undernutrition. It reflects the long-term and cumulative effects of dietary energy deficiency, micronutrient deficiency and infections since and before birth. It is indicated by a child's height being two standard deviations below normal for his or her age.
- *Wasting* is an indicator of acute undernutrition. It reflects a recent and severe process of substantial weight loss associated with caloric deprivation (dietary energy deficiency) or disease. It is indicated by a child's weight being two standard deviations below normal for his or her height (e.g. marasmus), a mid-upper arm circumference of less than 115 mm or bipedal pitting oedema (e.g. kwashiorkor).
- Finally, *overweight* reflects excess dietary energy. It is indicated by a child's weight being greater than two standard deviations above normal for his or her height.

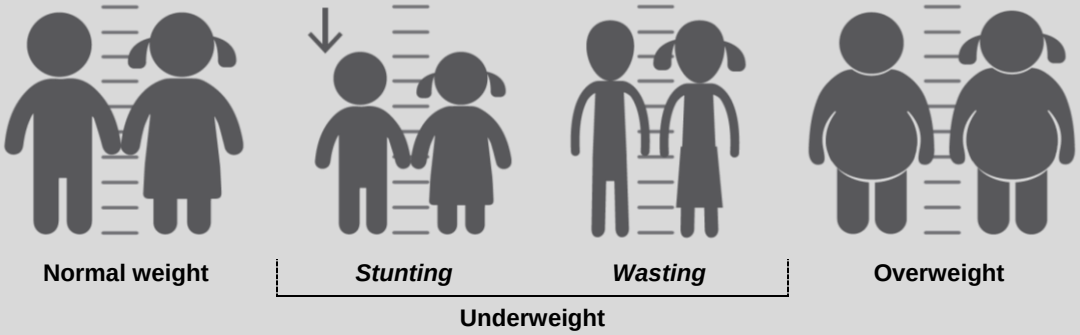
[19] Those indicators can be used to assess the progress made in the achievement of SDG2 target (2.2): "By 2030, end all forms of malnutrition, including achieving, by 2025, the internationally agreed targets on stunting and wasting in children under 5 years of age."

The body mass index (BMI) (WHO, 2010a), defined by a person's weight divided by the square of his height (kg/m^2), is often used as an easy population-level measure of the nutritional status of adults, even if it poorly captures differences in lean body mass and differences in body composition across age and sex (WHO, 1995):

- BMI < 17.0 indicates moderate and severe thinness
- BMI < 18.5 indicates underweight
- BMI from 18.5 to 24.9 indicates normal weight
- BMI ≥ 25.0 indicates overweight
- BMI ≥ 30.0 indicates obesity

Finally, clinical and biological measures of blood and urine (with new technologies becoming available) are the best predictors of micronutrient deficiencies. For instance, anaemia (i.e. haemoglobin concentration in the blood < 110 mg/ml), is often used as an indicator for iron deficiency (WHO, 2010a), even though iron-deficiency is not the only cause of anaemia around the world. Serum zinc is an important biomarker for zinc deficiencies but can be difficult to measure reliably (de Benoist *et al.,* 2007). Beyond biochemical measures from blood and urine, clinical indicators such as night-blindness for vitamin A deficiency and goitre for iodine deficiency can also be used as proxies for certain micronutrient deficiencies that have specific physical manifestations.

Figure 4 Common indicators for assessing childhood malnutrition



Source: Adapted from UNICEF (2016a).

2.1.1 Malnutrition: situation and trends

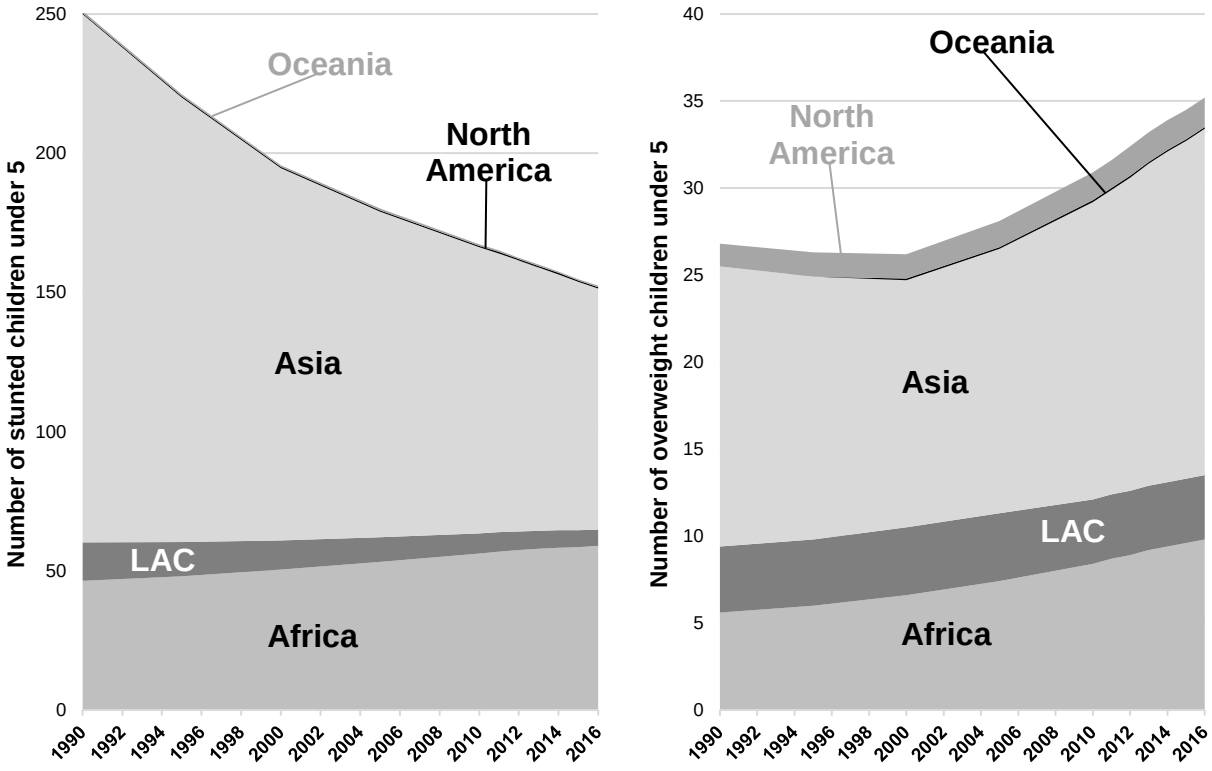
Undernutrition, overweight and obesity and non-communicable diseases

Globally, despite the progress made during the last decades, around 800 million people are still undernourished (FAO/IFAD/WFP, 2015; FAO/IFAD/UNICEF/WFP/WHO, 2017). The current crisis, with four countries (Nigeria, Somalia, South Sudan, Yemen) at risk of or facing famines, is likely to impact those global figures and to cancel part of the progress made in the fight against hunger.

Overall, child undernutrition is decreasing (Black *et al.*, 2013a), while child overweight and obesity are on the rise (**Figure 5**).

Undernutrition explains around 45 percent of deaths among children under five, mainly in LMICs (WHO, 2017a). The burden of stunting or chronic undernutrition in children under the age of five is significant. In 2016, 155 million children under the age of five (22.9 percent) worldwide were stunted, of which 87 million and 59 million reside in Asia and Africa, respectively. Globally, nearly 52 million children under the age of five (7.7 percent) were wasted or moderately acutely malnourished, of which 36 million and 14 million reside in Asia and Africa, respectively, and 17 million were severely wasted. Finally, almost 41 million children under the age of five (6 percent) were overweight or obese in 2016 compared to 30 million in 2000. Overweight and obesity now affect mainly young children living in developing countries, with 20 million overweight children in Asia, 10 million in Africa and 4 million in Latin America and the Caribbean (UNICEF/WHO/World Bank, 2017).

Figure 5 Numbers (millions) of stunted and overweight children under five years of age in Africa, Asia, Oceania, Latin America and the Caribbean, and North America



Notes: LAC = Latin America and the Caribbean. Data for Near East not available. Data for Australia, New Zealand and Europe negligible. Asia, excluding Japan; Oceania excluding Austraila and New Zealand; North America regional average based only on United States data.

Source: Data and regional classification from UNICEF/World Bank/WHO, 2017. Data set available at: http://www.who.int/nutgrowthdb/estimates2016/en/

Overweight and obesity are rapidly rising and now affect all countries: obesity worldwide has more than doubled since 1980. It is estimated that approximately 1.9 to 2.1 billion adults suffer from overweight and obesity of which over 600 million are obese, while 462 million adults are underweight (WHO, 2016a; WHO, 2017a; Ng *et al*., 2014). While undernutrition is still the main form of malnutrition among children under five, overweight and obesity represent the main burden for adults and WHO estimates that overweight and obesity are now responsible for more deaths than underweight (WHO, 2016a).

Micronutrient deficiencies

Micronutrient deficiencies are prevalent across the globe (Black *et al.*, 2013a) and deficiencies such as iron, iodine, vitamin A, folate, vitamin D and zinc can have devastating health consequences. While we cannot underestimate that significant and multiple micronutrient deficiencies exist due to inadequate local diets, poor sanitation and hygiene, broken public health systems and other underlying causes, there is currently no systematized way of measuring their magnitude and prevalence. Gaps in timely and frequent data collection, a lack of disaggregated data and slow development of new, cost-effective, low-resource methods and biomarkers limit the knowledge base on identifying nutrient deficits (von Grebmer *et al.,* 2014).

However, micronutrient deficiencies are estimated to affect more than two billion individuals worldwide (WHO, 2015c; Bailey *et al.,* 2015). While there are many micronutrients the body requires, and some deficiencies less understood, the most common micronutrient deficiency is iron deficiency (Bailey *et al.*, 2015). Vitamin A, iodine and zinc deficiencies are also common, particularly in young children and pregnant women (Bailey *et al.*, 2015) (**Table 4**). The micronutrient deficiencies of greatest public health concern also include vitamin D, folate, vitamin B_{12} and calcium deficiencies.

Table 4 Prevalence of vitamin A deficiency (2005), iodine deficiency (2013), inadequate zinc intake (2005) and iron deficiency anaemia (2011)

	Vitamin A deficiency				Iodine deficiency (UIC < 100 µmol/L)	Zinc Deficiency (weighted average of country means)	Iron deficiency anaemia (haemoglobin < 110 g/L)	
	Children < 5 years		Pregnant women					
	Night blindness	Serum Retinol < 0.70 µmol/L	Night blindness	Serum Retinol < 0.70 µmol/L			Children < 5 years	Pregnant women
Global	***0.9%***	***33.3%***	***7.8%***	***15.3%***	***28.5%***	***17.3%***	***18.1%***	***19.2%***
Africa	2.1%	41.6%	9.5%	14.3%	40.0%	23.9%	20.2%	20.3%
Americas and the Caribbean	0.6%	15.6%	4.4%	2.0%	13.7%	9.6%	12.7%	15.2%
Asia	0.5%	33.5%	7.8%	18.4%	31.6%	19.4%	19.0%	19.8%
Europe	0.7%	14.9%	2.9%	2.2%	44.2%	7.6%	12.1%	16.2%
Oceania	0.5%	12.6%	9.2%	1.4%	17.3%	5.7%	15.4%	17.2%

Data are percentages (95 percent confidence interval); UIC = urine iodine concentration.

Source: Black *et al. (*2013a).

2.1.2 Malnutrition: regional patterns

Although malnutrition is prevalent in every country, the relative importance of undernutrition, overweight and obesity and micronutrient deficiencies on human health differs across regions and countries.

Undernutrition

Asia and Africa bear the greatest burden of stunting and wasting among children. In 2016, they represented, respectively: 56 and 38 percent of all stunted and 69 and 27 percent of all wasted children under five years of age.

Between 2000 and 2016, Latin America and the Caribbean, Asia, and Africa have reduced their stunting rates among children under five years of age by 40, 37 and 18 percent, respectively. In absolute terms, these trends led to a decrease in the number of stunted children under five in Asia (–35 percent) and in Latin America and the Caribbean (–44 percent), while the number of African stunted children under five increased by 17 percent over the same period. Oceania is the only region where the prevalence of stunting increased among children under five between 2000 and 2016. These regional trends hide important disparities within regions. For instance, Southern Asia has reduced its stunting rate by 31 percent, whereas in Eastern Asia (excluding Japan), stunting rates dropped by 71 percent during the period under review (UNICEF/WHO/World Bank, 2017).

The prevalence of wasting in Southern Asia (15.4 percent) among children under five years of age far surpassed that of other regions of the world and accounts for over half of the global wasting burden (UNICEF/WHO/World Bank, 2017). Wasting remains an enormous issue, with high mortality risk among children, and is not always tied to famines and humanitarian crises. It can also occur among rural smallholders during seasons in which hunger persists. While the devastating famines of the kind that occurred in the nineteenth and twentieth centuries are less common today, they are unfortunately still occurring in the context of civil wars, conflicts and natural disasters, as in the Horn of Africa and Northern Nigeria, and it is expected that climate change may increase their frequency (de Waal, 2002; von Grebmer *et al*., 2015).

Overweight and obesity

More than 50 percent of the world's obese live in ten countries (ranked beginning with the countries with the highest number of obese people): United States of America, China, India, the Russian Federation, Brazil, Mexico, Egypt, Germany, Pakistan and Indonesia. The United States of America, the United Kingdom and Australia are among the HICs with large increases in obesity among men and women. Regionally, countries in the Middle East and North Africa, Central America and island nations in the Pacific and Caribbean have already reached exceptionally high rates of overweight and obesity (over 44 percent). Bahrain, Egypt, Saudi Arabia, Oman and Kuwait were among the countries with the largest increases in obesity globally in which the prevalence of obesity in women is over 50 percent. In sub-Saharan Africa, the highest obesity rates (42 percent) are seen among South African women (Ng *et al*., 2014).

To date, no country has reversed its obesity epidemic (Roberto *et al.*, 2015). HICs are still struggling with high prevalence of overweight and obesity. The prevalence of obesity is higher in North America and Oceania (31.1 and 25.3 percent, respectively) than in Western Europe and the Asia–Pacific (20.0 and 5.4 percent, respectively) (Stevens *et al.*, 2012). In the United States of America, more than two-thirds of adults are overweight or obese (Ogden *et al.*, 2014). In the United Kingdom, the most recent data available suggest 67 percent of men, 57 percent of women and over a quarter of children (26 percent of boys and 29 percent of girls) are overweight or obese (Ng *et al.*, 2014). These trends are still higher than in many LICs in Asia and Africa, with average BMIs of less than 21.5 kg/m^2 (Finucane *et al.*, 2011).

Overweight and obesity are increasingly affecting LMICs, not only in urban but also in peri-urban and even rural areas (Prentice, 2006). Paediatric obesity is too high and continues to rise in many LMICs as well as in HICs such as the United States of America and the United Kingdom (Kelly *et al*., 2013; Ells *et al*., 2015) (see **Box 5**). In 2013, the prevalence of both overweight and obese children and adolescents in HICs was estimated at 23.8 percent for boys and 22.6 percent for girls. In LMICs, the prevalence was estimated as 12.9 percent for boys and 13.4 percent for girls (Ng *et al*., 2014) with 49 and 24 percent of all overweight children under five living in Asia and Africa, respectively (UNICEF/WHO/World Bank, 2017).

Box 5 Tackling obesity in middle- and high-income countries: no silver bullets

Two recent reviews summarize the results of 114 studies that involved more than 13 000 children and young people in middle-income and high income countries (MICs and HICs) including Europe, the United States of America, Canada, New Zealand, Australia, Japan and Malaysia. They show that a combination of diet, physical activity and behavioural change interventions may reduce weight in children aged six to 11 years and in adolescents aged 12 to 17, but there are limitations in the studies and variation in the results. In children, these interventions may have a small, short-term effect in reducing children's weight and body mass index-z score (a proxy measure of body fat based on weight in relation to height, sex and age) (Mead *et al.,* 2017). In adolescents, there was moderate-quality evidence that the combined interventions reduce adolescent weight by an average of 3.7 kg (Al-Khudairy *et al.,* 2017).

In urban Beijing, China, children and their parents took part in a three-year study on nutrition education and physical activity. At the same time, a control group of children was followed with their usual health and physical education curriculum with no extra intervention (n = 2425). After the three-year intervention, the prevalence of overweight and obesity was significantly lower in the intervention schools than in the control schools (overweight: 9.8 vs 14.4 percent, $P < 0.01$; obesity: 7.9 vs 13.3 percent, $P < 0.01$). The prevalence of overweight and obesity decreased by 26.3 and 32.5 percent in intervention schools, respectively, after intervention. The prevalence of overweight and obesity increased in control schools. There was also significant difference in body mass index between intervention and control schools (18.2 +/- 2.6 vs 20.3 +/- 3.4, $P < 0.01$) after intervention. More non-obese children became obese in the control schools (7.0 percent) than in the intervention schools (2.4 percent) at end line ($P < 0.01$) (Jiang *et al.,* 2007).

In MICs and HICs, non-profit organizations and public health agencies at all levels of government are working to reduce overweight and obesity among adults and children. Taxation on sugar-sweetened beverages (SSBs) is an emerging fiscal policy to potentially play a role in reducing obesity; however, no evidence has yet emerged on its impact beyond soda purchases. Regulatory bodies have also begun to standardize health claims on food packaging and nutrition fact labels throughout the food industry. Programmes aimed at reducing childhood obesity tend to create lessons for both the classroom and families at home, targeting both food choice and physical activity.

Open discourse and public–private partnerships are essential to address complex food and nutrition issues that lead to obesity (Yach, 2014). Further coordination between food producers, regulating bodies and policy-makers is critical to ensuring nutrition interventions are multi-sectoral in nature, effectively increasing children's knowledge on nutrition while simultaneously encouraging healthy food choices and adequate physical activity.

Micronutrient deficiencies

Many countries in Southeast Asia and Western, Central and Eastern Africa are still heavily affected by micronutrient deficiencies (Andersson *et al.*, 2012; Stevens *et al.*, 2013, 2015; Kumssa *et al.*, 2015). While these deficiencies mostly affect LMICs (Bailey *et al.*, 2015), HICs have pockets of poverty where micronutrient deficiencies still exist and deficiencies in iron, zinc and vitamin D are widespread across all socio-economic strata (WHO, 2009a; Low *et al.,* 2009).

Among pre-school children, 67.6 and 65.5 percent have anaemia in Africa and Southeast Asia, respectively. In pregnant women, 57.1 and 48.2 percent have anaemia in Africa and Southeast Asia, respectively (De Benoist *et al.*, 2008). As shown in **Table 4**, vitamin A deficiency also affects Africa and Asia (WHO, 2009b). Fifty-two percent of European populations are estimated to have inadequate iodine status, and 500 million individuals are affected in Southeast Asia. Approximately 30 percent of the world's school-aged children have insufficient iodine intakes (Bailey *et al.*, 2015). Measuring folate deficiency among women of reproductive age, pregnant females and young children can be a challenge (Bailey *et al.*, 2015). However, periconceptional folic acid intake has been shown to prevent neural tube defects such as spina bifida (De-Regil *et al.*, 2015) and fortification of flour with folic acid has dramatically reduced congenital abnormalities such as neural tube defects in several countries worldwide (Castillo-Lancellotti *et al.*, 2013).

Deficiencies in zinc are also a challenge to assess due to shortcomings in biomarker essays. Instead, zinc deficiencies are often estimated by the prevalence of child stunting and availability of zinc in the food supply. Globally, it is estimated that 17.3 percent of the population has inadequate zinc intakes, with the highest estimates in Africa (23.9 percent) and Asia (19.4 percent) (Bailey *et al.*, 2015).
It should be noted that micronutrient deficiencies are usually multiple in one person, making it a challenge to estimate global hidden hunger.

Disparities within countries

There are also significant differences in the distribution of malnutrition within countries between socio-economic groups and among those more or less educated.

Women and children are often the most affected. For instance, as countries transition to higher rates of development and as a country's gross national product (GNP) increases, obesity shifts to economically disadvantaged groups. These trends are particularly evident among women (Dinsa *et al.*, 2012; Monteiro *et al.*, 2004). Although rates of obesity in children are increasing globally, it is predominantly a problem of the wealthy in LMICs (Dinsa *et al.*, 2012), as compared with a problem of all socio-economic strata in HICs.

This unequal distribution of malnutrition across socio-economic status also appears for undernutrition, and Black *et al.* (2013a), based on data from Bangladesh, Brazil and Nigeria, show that, although stunting declined over time, stunting prevalence remains higher in low-income households and in rural areas. They also highlight the strong reduction of inequalities in stunting prevalence, observed in Brazil between 1996 and 2006, between low- and high-income households, as well as between rural and urban areas, showing that policies and programmes has to be adapted to the different needs of specific groups.

2.1.3 Vulnerability to malnutrition

People that are vulnerable to nutrient deficiencies typically include those with increased nutrient requirements (at some point in the life cycle), and also those who have less control over their choice of diet, including young children, adolescent girls, pregnant and lactating women, the elderly, people who are ill or immuno-compromised, and the rural and urban poor (Black *et al.*, 2008). Those groups migrating or displaced due to conflicts, droughts, floods and other natural disasters, famines or land tenure issues are also at acute risk and vulnerable to malnutrition.

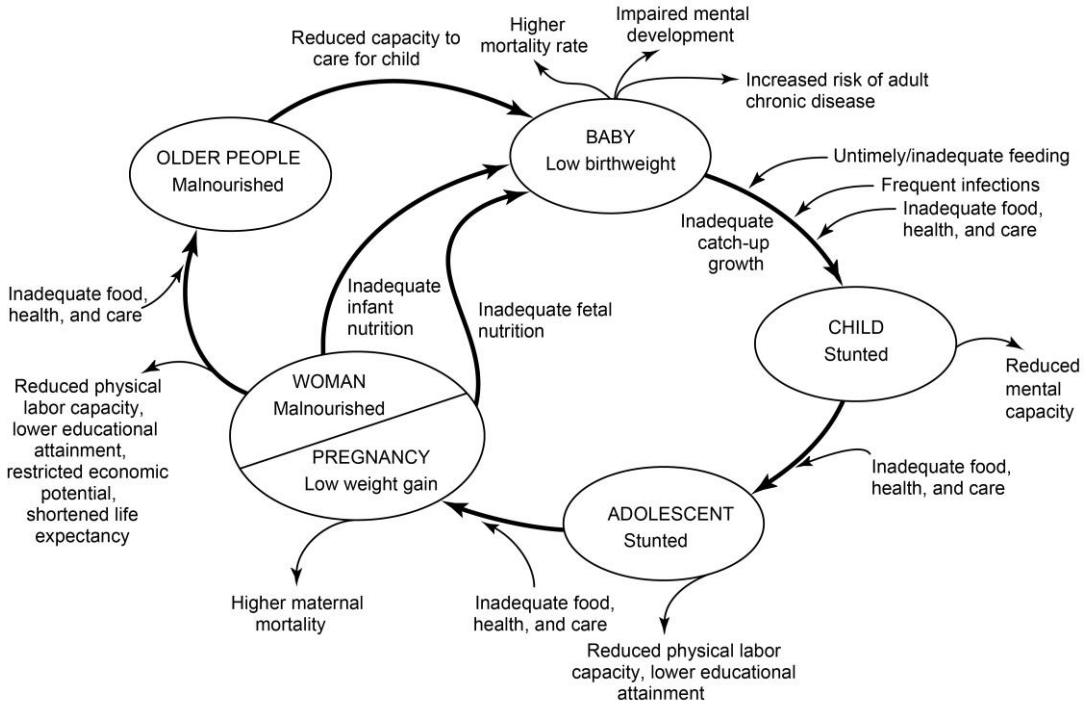
Indigenous peoples are generally among the most vulnerable to different forms of malnutrition because of: marginalization; extreme poverty; violations of their inherent rights to their traditionally occupied or used lands, territories and resources; environmental and ecosystem degradation; and decline in their traditional food sources. In Latin America, for instance, mortality remains 70 percent higher among indigenous children and malnutrition is twice as frequent (UNDESA, 2009). Recent evidence shows that they have higher rates of infant mortality, maternal mortality, low birth weight, child malnutrition, child obesity and adult obesity, lower educational attainment and economic status than non-indigenous peoples (Anderson *et al.*, 2017).

The ”first 1 000 days”, from conception through a child’s first two years of life, are the most crucial period for influencing long-term nutritional and health outcomes (World Bank, 2006; Black *et al.*, 2013a). The need to focus on the prevention of malnutrition in early life is further stressed by the concept of the foetal origins of adult disease in which early exposures have profound impacts on adult health outcomes (Barker *et al.*, 2002; Calkins and Devaskar, 2011). There is a potential to limit malnutrition during the “first 1 000 days” and its subsequent consequences on health and nutrition status in adulthood through “double-duty actions”, such as promoting exclusive breastfeeding and maternal nutrition, that have the potential to address simultaneously multiple forms of malnutrition (WHO, 2017b).

Malnutrition affects the entire life cycle beyond the first 1 000 days, and its effects can extend across generations (**Figure 6**). In particular, the nutrition status of a pregnant woman affects the birth outcomes and nutritional status of her children and their subsequent health and nutritional status as infants and potentially into adulthood. All women have increased micronutrient needs during pregnancy and lactation. These can be met with their bodily nutrient reserves if they are unable to consume additional food to cover them; however, tapping into those reserves is far from ideal (Black *et al.*, 2008).

Although **Figure 6** focuses on undernutrition, overweight and obesity can also confer health risks to future generations. Maternal obesity and excessive weight gain during pregnancy are both associated with increased risks of adverse maternal, foetal and childhood health outcomes (Gaillard *et al.*, 2013). There are also associations between maternal overweight (and maternal diet) and the risk of a child being obese or diabetic (Hanson and Gluckman, 2015; Lelijveld *et al.*, 2016). Some evidence also indicates a relationship between overweight children and the risk of developing micronutrient deficiencies (Nead *et al.,* 2004; Zimmermann *et al.,* 2008; Cepeda-Lopez *et al.,* 2011; Tzioumis and Adair, 2014).

Figure 6 The burden of undernutrition through the life cycle and across generations



Source: Adapted from ACC/SCN (2000), available at: https://www.unscn.org/web/archives_resources/files/rwns4.pdf

2.2 The consequences of malnutrition

2.2.1 Health consequences

A considerable body of evidence highlights the links between malnutrition in all its forms and disease development (e.g. Magni *et al.,* 2017; Sotos-Prieto *et al.,* 2017).

Undernutrition

In the short term, undernutrition increases the risk of morbidity and mortality (Hoddinott *et al.*, 2012). Newborns with low birth weight have greater mortality risk, are more frequently affected by, and less resistant to, infectious diseases during early postnatal life, and are candidates for future NCDs (Godfrey and Barker, 2001).

Wasting, or acute undernutrition, poses the greatest risk of morbidity and mortality. Though the number of children who are wasted is smaller, wasted children are at higher risk of death from common childhood illnesses (Black *et al.*, 2013b).

Stunting, or chronic undernutrition, causes delays in both physical growth and cognitive development. Poor nutrition in the first two years of life has important consequences into adulthood (Victora *et al.*, 2008; Martorell *et al.*, 2010; Adair *et al.*, 2013), inhibiting a child's ability to reach its full potential. Additionally, a stunted person has higher risk of poor pregnancy outcomes and impaired cognition into adulthood (Hoddinott *et al.*, 2012). **Box 6** outlines a success story from India on how a high burden of stunting was tackled.

There is a relationship between early human development and the risk of NCDs in later life. It has been observed that lower birth weight and stunting confer a higher probability of future risk of overweight and associated NCDs (Barker *et al.*, 2002; Sawaya *et al.*, 2003; Victora *et al.*, 2008; Uauy *et al.*, 2011; Norris *et al.*, 2012; Prentice *et al.*, 2013).

Box 6 Maharashtra, India, as a case study for significant reductions in stunting

With a population of 112 million and including the city of Mumbai, Maharashtra is India's third more populated state. It is also one of the wealthiest and most developed. Maharashtra is notable for its steady decline in childhood stunting rates. While stunting rates remained both high and stable throughout India, stunting fell from 39 percent to 24 percent among children under age two, and from 45 percent to 30 percent for children under age five in Maharashtra from 2005 to 2013. Haddad *et al.* (2014) propose four primary take-away conclusions of Maharashtra's significant decline in stunting.

First, the state maintained an enabling environment for stunting reduction. Economic growth was steady; poverty reduction was higher than averages across the country. Budgets for nutrition programming increased by 0.5 percent between 2009 and 2011. Women maintained a relatively high status in Maharshta compared with other Indian states, including high female literacy, and low maternal mortality and anaemia rates. The state invested in child health care and nutrition interventions in a variety of programmes, including the National Rural Health Mission and Integrated Child Development Services. The government also declared its commitment to improve nutrition through the Nutrition Mission. As a result, Haddad *et al*. (2014) found that even small positive changes in nutrition determinants can initiate significant changes in stunting rates.

Second, they noted that stunting rates can decline, although important underlying determinants of malnutrition, including safe water and sanitation, agricultural growth and health care, exhibited little to no progress. Third, they indicated that nearly a decade passed before the effects of the aforementioned policy of social and health intervention could fully transpire throughout Maharashtra. Significantly lower stunting rates in 2012 reflected substantial commitments from a wide range of actors and stakeholders since the early 2000s. Last, state and individual leadership signalled stunting reduction as a political priority.

The Maharashtra experience indicates that a supportive socio-economic context can facilitate the union of government and civil society to lead multi-sectoral interventions, successfully, significantly and quickly reducing undernutrition.

Sources: IIPS (2012); MHFW (2014); Haddad (2014); Haddad *et al.* (2014).

Overweight and obesity

In 2010, around 3.4 million deaths per year and 3.8 percent of the global burden of disease, expressed in disability-adjusted life-years (DALYs),[20] were attributed to excess weight (Lim *et al.*, 2012; Ng *et al.,* 2014). A study reviewing the health consequences of overweight and obesity in 195 countries over 25 years (GBD, 2017) found that, in 2015, excess BMI contributed globally to an estimated 4 million deaths (7.1 percent of all deaths) and accounted for 120 million DALYs (4.9 percent of all DALYs among adults).

Overweight and obesity are major risk factors of NCDs – mainly cancer, cardiovascular disease (CVD), chronic respiratory diseases and diabetes (WHO, 2011; Lozano *et al.*, 2012). NCDs are currently the most common cause of death and disability worldwide, accounting for over 60 percent of global mortality, or two out of every three deaths (Islam *et al.*, 2014).

NCD-related deaths have escalated significantly in the recent past. Since 2000, all regions of the world have suffered an increase in the number of NCD-related deaths (Ezzati and Riboli, 2013). Of the 38 million deaths due to NCDs in 2012, 16 million or 42 percent were premature and largely avoidable – up from 14.6 million in 2000 (WHO, 2014a). 75 percent of these NCD related deaths and 82 percent of premature deaths occur in LMICS (WHO, 2014a). Premature death is a major concern, especially in LMICs, where higher death tolls are also associated with poorly functioning health systems. NCDs are killing people at a younger age in LMICs: where 30 percent of NCD-related deaths occur before the age of 60, the productive age bracket, as compared with 13 percent in HICs (Harikrishnan *et al.*, 2014; WHO, 2010b).

CVD alone is a significant cause of premature death and the primary driver of morbidity for all NCDs, the largest burden of which occurs in LMICs (Zoghbi *et al.*, 2014). Diabetes' prevalence tracks the transitions that lead to the precursors of CVD – namely obesity and overweight (Atun *et al.*, 2017). Globally, the number of adults with diabetes increased from 108 million (a prevalence of 4.7 percent) in 1980 to 422 million (8.5 percent) in 2014 – an increase in prevalence of 80.9 percent (NCD-RisC, 2016). Notably, from 1980 to 2014, diabetes' prevalence has increased 109.8 percent in South Asia, and 129 percent in Africa (NCD-RisC, 2016). The overall prevalence of diabetes in all 15 states of India is 7.3 percent with large differences between states, and tends to be higher in urban centres and in lower socio-economic groups (Anjana *et al.*, 2017).

Micronutrient deficiencies

Even mild to moderate micronutrient deficiencies can affect human health, well-being and development.

Children under five, women of child-bearing age and pregnant women are particularly at risk. Several chronic diseases are frequently associated with iron deficiency anaemia – notably chronic kidney disease, chronic heart failure, cancer and inflammatory bowel disease (Lopez *et al.*, 2016). **Box 7** provides a case study from Costa Rica on how the country tackled anaemia through iron fortification of major food commodities.

Box 7 Food fortification (wheat flour, maize flour, milk) with iron in Costa Rica

Costa Rica has been a pioneer of mass fortification in many foods and condiments. Although wheat flour was first fortified with iron in 1958, there has been a stronger push for iron fortification in the country since the 1990s. Reduced iron, an ineffective fortifiant, was replaced by ferrous bisglycinate in maize flour in 1999, in liquid and powdered milk in 2001, and ferrous fumarate was added in wheat flour in 2002. To examine the impact of the fortification programme, the anaemia prevalence in women (15 to 45 years) and children (1 to 7 years) was examined before (1996) and after (2008 to 2009) the mandatory fortification using national survey data of 910 women and 965 children before and 863 women and 403 children after the introduction of the programme. During this period, anaemia declined from 19.3 percent to 4.0 percent in children and from 18.4 percent to 10.2 percent at the national level. Moreover, iron deficiency declined from 26.9 percent to 6.8 percent in children, and iron deficiency anaemia declined from 6.2 percent to no longer detectable.

Source: Martorell *et al, (*2015).

[20] "DALYs for a disease or a health condition are calculated as the sum of the years of life lost (YLL) due to premature mortality in the population and of the years lost due to disability (YLD) for people living with the health condition or its consequences. One DALY can be thought of as one lost year of "healthy" life. See: http://www.who.int/healthinfo/global_burden_disease/metrics_daly/en/ (accessed September 2017).

Vitamin A deficiency is the leading cause of preventable blindness in children. It causes severe visual impairment and blindness and compromises the immune system, significantly increasing the risk of severe illness and even death from childhood infections such as diarrhoeal diseases and measles (UNSCN, 2004). In pregnant women, vitamin A deficiency occurs especially during the last trimester, when demand by both the foetus and the mother is at its highest (Ladipo, 2000). Maternal deficiency is demonstrated by the high incidence of night blindness during this period. Vitamin A deficiency increases the risk of maternal mortality.

Iodine deficiency disorders, which can start before birth, compromise children's mental health and even their survival. Serious iodine deficiency during pregnancy can result in stillbirth, spontaneous abortion and congenital abnormalities such as cretinism (Bailey *et al.*, 2015). Iodine deficiency disorder results in pervasive mental impairment that reduces intellectual capacity at home, in school and at work (de Benoist, 2008).

Zinc is an important nutrient for normal pregnancy outcomes and child growth, including resilience against diseases and brain development (Brown *et al.*, 2004). Zinc deficiency results in growth retardation, lower immunity to diseases and cognitive impairment, among other issues (Bailey *et al.*, 2015). **Box 8** provides case studies in addressing micronutrient deficiencies through food-based strategies to improve dietary diversity.

Box 8 Tackling micronutrient deficiencies through dietary diversity approaches

Food-based approaches, through improvements in dietary diversity, are emerging as a potential solution to address micronutrient deficiencies in addition to other interventions such as fortification of flour, oil and salt, biofortification of key staple crops and micronutrient powders to add to infant foods. Helen Keller International's homestead food production programme paired with behaviour change communication targeting women has been steadily cumulating evidence of their impact on micronutrient and anthropometric status among women and children. In Bangladesh and the Philippines, anaemia prevalence among children decreased concomitantly with increased consumption of ASF especially eggs (Talukder *et al.*, 2010). In Burkina Faso, anaemia (along with wasting and diarrhoea) decreased in young children with increased production of vitamin A–rich fruits and vegetables and other fruits and vegetables and dietary diversity (Olney *et al.*, 2015). In Bangladesh, the increased consumption of Mola, a nutrient-rich, small fish found in ponds and rice fields in Bangladesh, had an impact on iron status in children with marginal vitamin A status (Andersen *et al.*, 2016).

2.2.2 Economic and social consequences

The economic cost of malnutrition is high. The effect of chronic malnutrition in children extends into adulthood, resulting in reduced stature, poor school performance, reduced economic productivity and diminished earnings (Hoddinott *et al.*, 2012). Victims of stunting are less productive workers, and they make a reduced contribution to the economy (Alderman *et al.*, 2006). Diseases associated with chronic malnutrition also lead to significant spending on health care (Hoddinott *et al.*, 2013).

Malnutrition imposes various direct and indirect costs (Global Panel for Agriculture and Food Systems for Nutrition, 2016b). At the global level, the costs associated to undernutrition and micronutrient deficiencies are estimated at 2 to 3 percent per year (World Bank, 2006; FAO, 2013a). When considering diet-related NCDs associated with obesity, the cost of malnutrition can reach 5 percent of global GDP (FAO, 2013a). In LICs, the cost of productivity lost due to undernutrition are estimated to reach 3 to 16 percent of GDP (Hoddinott, 2016). Cross-country data on sub-Saharan African countries suggests that a loss of one percent of potential height in adulthood reduces earnings by 2.4 percent (Hoddinott, 2016). Another study (Steckel and Horton, 2011) estimates that the loss of individual height translates to an annual loss that can reach 12 percent of GDP in LICs.

Socio-economically disadvantaged children in HICs and children of higher socio-economic status in LMICs are at greater risk of becoming overweight (Knai *et al.*, 2012; Lobstein *et al.*, 2004 Wang and Lim, 2012). However, this relationship varies when taking into account other factors such as demographics (age, gender, ethnicity or race), urbanization and functional health-care systems.

Micronutrient deficiencies have similar economic consequences. For instance, iron deficiency and anaemia, in addition to iodine deficiency disorders, reduce the work capacity of individuals and of entire populations (Horton and Ross, 2003; de Benoist, 2008), entailing serious economic consequences and hampering national development, particularly in LMICs.

Medical costs and overburdened health systems are also associated with malnutrition. Evidence from various countries shows that individuals who are obese incur higher health costs than individuals who are not, and that they are more frequently absent from work (Dee *et al.*, 2014). Obese individuals have medical costs that are about 30 percent higher than their normal-weight counterparts, and obesity may account for up to 3 percent of a country's total health-care expenditures (Withrow and Alter, 2011).

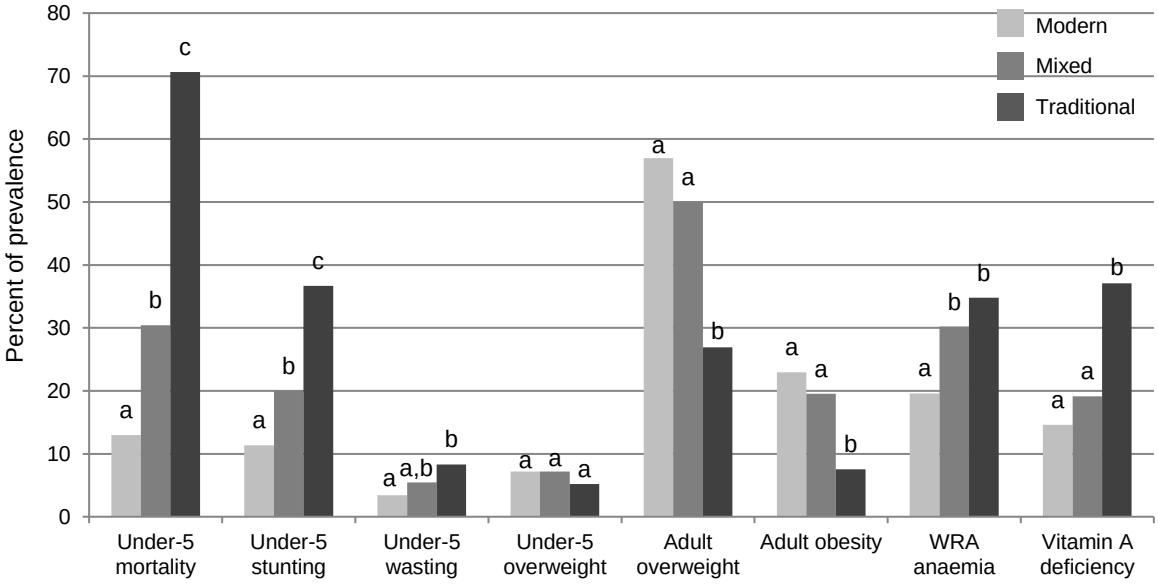
Globally, it is estimated that, from 2011 to 2025, the economic burden of NCDs will be USD 7 trillion, with CVD accounting for most of that expense (Zoghbi *et al.*, 2014). In 2015, the overall cost of diabetes in sub-Saharan Africa alone was USD 19.45 billion or 1.2 percent of cumulative GDP (Atun *et al.*, 2017).

Social, cultural and psychological consequences also result from malnutrition. For instance, in some HICs, excess body weight triggers the onset of disorders associated with poor self-esteem, body image and social interactions. This also holds true for low body weight (Bliss *et al.*, 2016). Evidence also points to discrimination in society and the workplace, social exclusion and even lower earnings. Cawley (2004) found that high body weight was associated with lower wages, even in a high-income setting. It should be noted that this is not the case in all countries: overweight can also be symbolic of status and power.

2.3 Nutrition outcomes across food system types

Though it is recognized that multiple food systems can co-exist within a country, associating specific food system types with malnutrition burdens can provide a general snapshot of how the multiple burdens play out across a system. **Figure 7** illustrates health and nutrition outcomes (under five years of age mortality, stunting, wasting and overweight; adult overweight and obesity; women of reproductive age anaemia; and overall vitamin A deficiency) related to different food system types using country-level data and classifying countries according to their dominant food system type. However, it should be noted that there are many nuances within the broad range of causes of malnutrition in all its forms, thus national policies must be designed or adapted to the local context.

Figure 7 Prevalence of health and nutrition outcomes across different food system types



Notes: WRA = women of reproductive age. Values that fall within the same confidence interval are indicated with same letters (e.g. "a" applied to an indicator for different food systems means that the difference observed between these two food systems on that indicator is not statistically significant; see as an example Under-5 overweight).
Methodology: Countries were categorized into values that were above and below the median, for the following indicators: dietary energy in food supply (kcal/capita/day, FAO Food Balance Sheets), urbanization (percent, UNDESA), food affordability (index value, Global Food Security Index), and presence of food-based dietary guidelines (yes/no, FAO). Countries that had data for these four indicators (n=108) were considered. Countries with *all four indicators above* the median were categorized as mostly modern food system; countries with *all four indicators below* the median were categorized as mostly traditional food system; and countries with indicators *both below and above* the median were categorized as mostly mixed food system. To determine the associations between different food system types and nutrition outcomes, food system types were evaluated using the prevalence of the following national-level nutrition data: under-five mortality, under-five stunting, under-five wasting, under-five overweight, adult overweight, adult obesity, anaemia in women of reproductive age and overall vitamin A deficiency.

Traditional food systems are associated with the highest prevalence of undernutrition, including stunting, wasting and under-five mortality, as well as the highest prevalence of micronutrient deficiencies. Although they are associated with lower levels of overweight and obesity in adults, the prevalence of adult overweight is still around 28 percent in those systems.

Mixed food systems experience moderate levels of all burdens of malnutrition: undernutrition, overweight and obesity, and micronutrient deficiencies. This presents challenges for countries, in terms of prioritization of policies and programmes to tackle the multiple burdens.

Modern food systems are associated with lower levels of undernutrition and micronutrient deficiencies, but higher levels of overweight and obesity, particularly among adults. Even with lower levels of micronutrient deficiencies, anaemia still affects nearly 20 percent of the population in these systems.

2.4 Conclusion

Good health and nutrition are only possible if effective food systems cover the dietary needs of everyone on the planet, including the world's marginalized and most disadvantaged groups. Malnutrition in all its forms is a challenge for all countries, whether developed or developing. Certain groups are particularly vulnerable to malnutrition, including pregnant and lactating women, adolescent girls, young children, the elderly, people who are ill or immune-compromised, the rural and urban poor and indigenous peoples.

Although undernutrition has declined in many regions of the world, overweight and obesity, along with NCDs, are on the rise everywhere. Typically associated with HICs, overweight and obesity are now dramatically increasing in LMICs. Like undernutrition, overweight and obesity represent a significant burden for national budgets, in terms both of direct and indirect costs. In the next chapter, the current transitions and future trends of diets will be elucidated.

3 DIETS IN TRANSITION

One of the major causes of malnutrition and its subsequent health outcomes is diets. Unhealthy diets[21] are now the number one risk factor globally for deaths and disability-adjusted life-years (DALYs) lost (Forouzanfar *et al.,* 2015), surpassing for example tobacco smoking and high blood pressure.

There are many influencing factors that trigger dietary changes from both the supply and demand sides of food systems. This chapter provides an overview of current and future dietary patterns, trends and transitions within the context of food systems, highlights specific groups that are more fragile to these transitions from a diet perspective, and describes the influencing factors that shape dietary decisions.

3.1 Changing diets

Global dietary patterns have been changing, affecting people in all parts of the world. While some of these changes have had a positive effect on diets that promote health, some have been negative, across low-, middle- and high-income countries.

3.1.1 Current food consumption trends and dietary patterns

FAO food balance sheets are often used to characterize diets (e.g. Keats and Wiggins, 2014). However, food balance sheets measure food supply and not food intake. FAO and WHO are developing a Global Individual Data Base on Food Intake (GIFT)[22] that, once completed, promises to represent a global valuable resource on diets. This project will build on existing similar initiatives in order to share experiences and avoid duplication. Among those initiatives, is the Global Dietary Database (GDD),[23] developed by the Global Nutrition and Policy Consortium at the Tufts Friedman School of Nutrition Science and Policy (Boston, United States of America). The GDD draws together household surveys that measure actual diets. The Global Dietary Database is an emerging database that is capturing country level data of dietary intake. Along with FAO's food balance sheets, this database provides more specific information on diets and how they are changing over time.

Building on the results of the GDD for the year 2013, the Global Panel on Agriculture and Food Systems for Nutrition (GloPan) classified different food items in two categories: "healthy foods" or foods that one should consume as part of a regular diet (Panel A) and "unhealthy foods" or foods that should be consumed in moderation or limited (Panel B) in order to analyse dietary patterns across regions.[24] This analysis revealed substantial regional variations in consumption (**Figure 8**).[25]

In Panel A, fruit consumption is higher in higher-income regions as compared with low-income regions, whereas vegetable consumption is lower. Consumption of seafood is relatively low globally, with the highest levels in South East Asia. Dairy consumption is highest in North America and EU-15.[26]

In Panel B, red meat consumption is similar in East Asia, Latin America, North America and EU-15. Trans fat intake is highest in South Asia, whereas the consumption of sugar-sweetened beverages (SSBs) is highest in Latin America and North America.

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[21] Typically, unhealthy diets are those low in fruits, vegetables, whole grains, nuts and seeds, milk, fibre, calcium, seafood and fish high in omega-3 fatty acids, and polyunsaturated fatty acids, and diets high in red meat, processed meat (smoked, cured, salted or chemically preserved), SSBs, trans fats and sodium (Forouzanfar *et al.,* 2015). Highly-processed foods are usually characteristically high in salt, trans fats and added sugar (Baker and Friel 2014; Monteiro *et al.,* 2013).

[22] http://www.fao.org/fileadmin/user_upload/nutrition/docs/assessment/FAO-WHO_GIFT_project_brief_-_February_2017.pdf

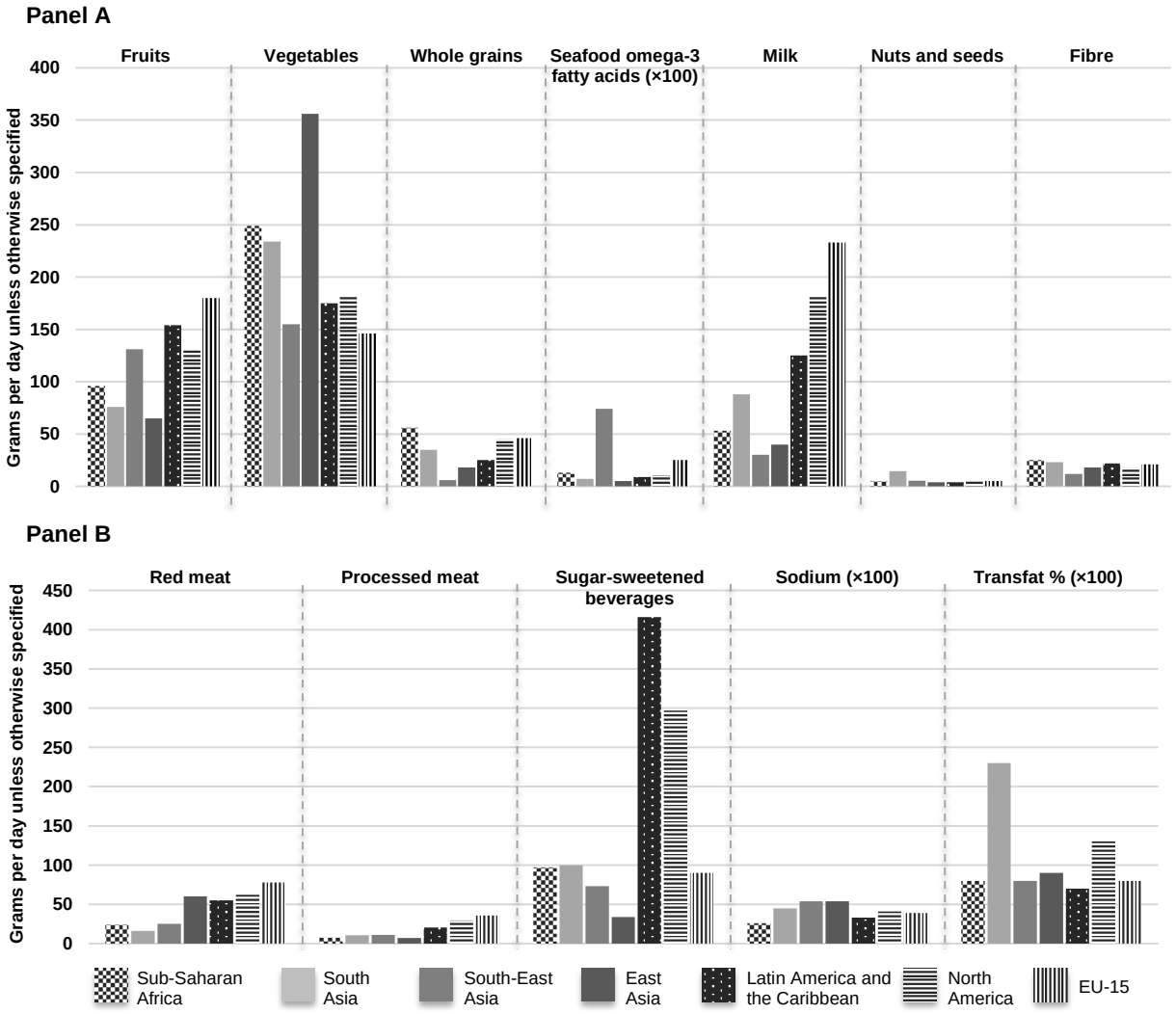
[23] http://www.globaldietarydatabase.org/

[24] See section 1.3.1 for a discussion on "healthy" and "unhealthy" foods.

[25] The regions and subregions, as defined in the Global Dietary Database and used in this section, may differ from the FAO regions.

[26] The term EU-15 refers to the 15 Member States of the European Union as of December 31st, 2003.

Figure 8 Intake of key foods and diet components, by region, 2013



Source: GloPan (2016a), Masters (2016) based on data and regional classification from the Global Dietary Database.

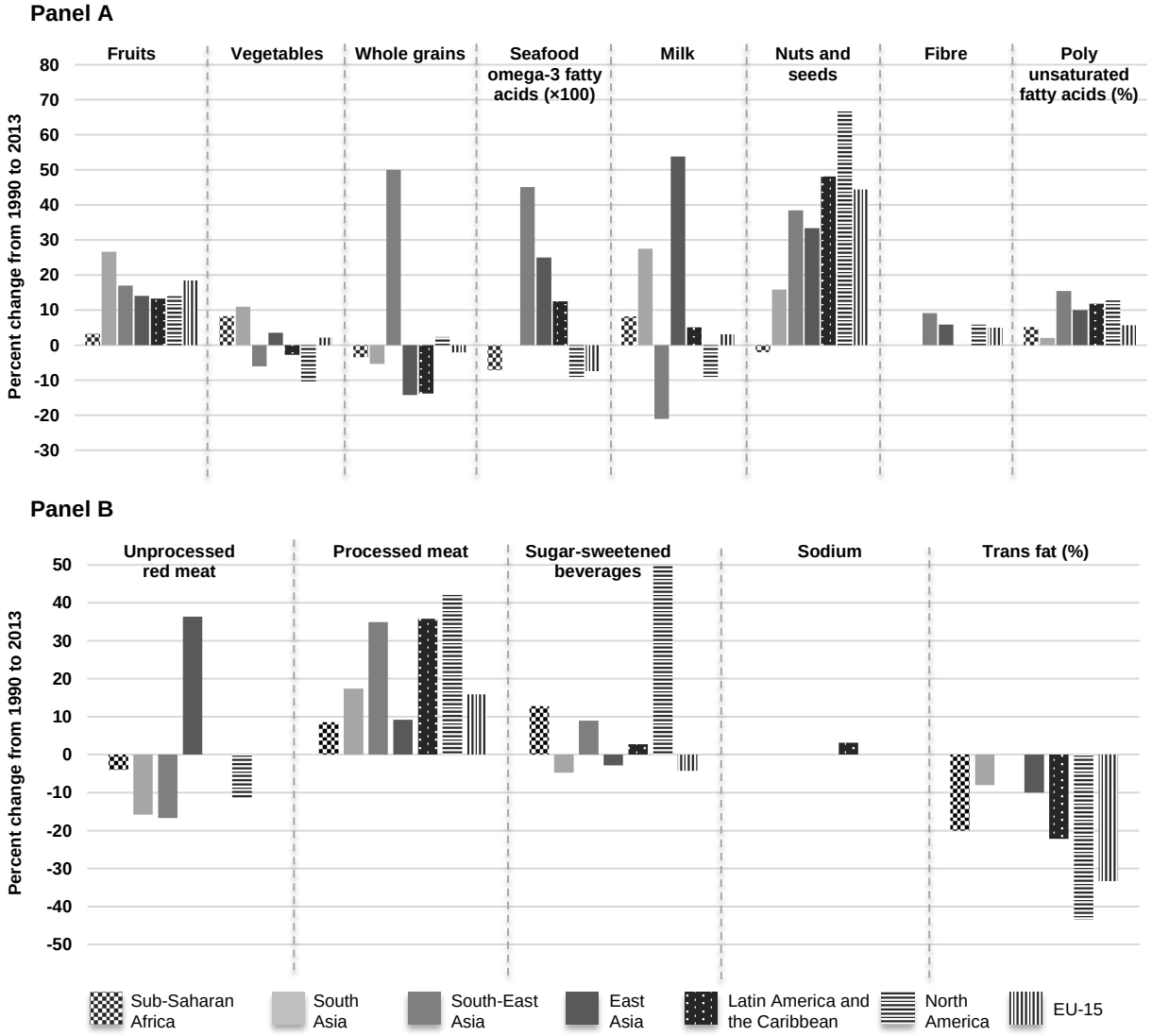
Changes in the consumption per capita of the food groups as well as dietary components such as polyunsaturated fats, sodium, etc, comparing data from 1990 to 2013, are shown in **Figure 9.**

In Panel A, consumption of most food groups and dietary components has generally grown in all regions over the period from 1990 to 2013. However, there are some important differences across food group types. Fruit consumption increased in all regions, while vegetable consumption increased in just four out of the seven regions. The intake of whole grains rose substantially only in Southeast Asia, while consumption of seafood declined in three out of the seven regions.

In Panel B, changes over the period are more varied. The intake of trans fats declined in all regions. A decade and a half ago, the European Union supported a systematic study in 14 European countries to analyse the trans fats content of the food supply (van Poppel, 1998). This has led to voluntary reformulation of some products and technology improvements on the part of the food industry. In the United States of America, meanwhile, the United States Food and Drug Administration (FDA) is in the process of banning trans fats from the country's food supply. Red meat consumption declined everywhere except in East Asia, where it rose by nearly 40 percent.[27] Consumption of processed meat also increased in all regions, while sugar-sweetened beverage consumption has grown in more than half the regions, with the largest increase in North America. Changes in salt/sodium consumption have been minimal in all regions.

[27] The decline in South and Southeast Asia and sub-Saharan Africa may reflect a substitution of red meat by other types of fresh meat, but the current data do not allow this possibility to be assessed.

Figure 9 Changes in intake of key foods and diet components by region, 1990–2013 (percent)



Source: GloPan (2016a), Masters (2016) based on data and regional classification from the Global Dietary Database.

Imamura *et al.* (2015) also examined dietary patterns in 1990 and 2010 across 187 countries, by age and sex, using a wide range of data sources, including FAO food balance sheets as well as nationally representative and large subnational dietary surveys. They scored the quality of three dietary patterns: the first one based on the consumption of ten "healthy" food items (fruits, vegetables, beans and legumes, nuts and seeds, whole grains, milk, total polyunsaturated fatty acids, fish, plant omega-3s and dietary fibre); the second based on the consumption of seven "unhealthy" food items (unprocessed red meats, processed meats, SSBs, saturated fat, trans fat, dietary cholesterol and sodium); and the third one integrating the 17 food items. They highlighted, at the global level, between 1990 and 2010, an increased consumption of both "healthy" and "unhealthy" food items, the latter outpacing the former in most regions.

Food quality and safety is of growing concern. Interestingly, ASF, fruits and vegetables, while highly nutritious, are the foods most responsible for food-borne diseases (FBD) thus recommending these foods for nutrition without addressing food safety issues would result in net worsening of health (Grace, 2017). In 2010, according to WHO, approximately 600 million people fall ill from consuming food contaminated by bacteria, viruses, parasites, toxins or chemicals. Thirty-two global FBD accounted for at least 33 million DALYs and provoked 420 000 deaths. Diarrhoeal diseases alone affected 550 million people, accounted for 18 million DALYs, and provoked 230 000 deaths. Forty percent of the global FBD burden is borne by children under five (WHO, 2015d).

3.1.2 Shifts in dietary patterns: the nutrition transition

The "nutrition transition", illustrated in **Figure 10**, refers to changes in dietary patterns as populations undergo demographic transition,[28] urbanization and economic development. These shifts subsequently influence epidemiological patterns among those populations that are undergoing lifestyle changes (Popkin, 2006a; Drewnowski and Popkin, 1997).

In traditional food systems, including hunter–gatherer systems and subsistence rural communities (Frassetto *et al.*, 2009), people eat mainly local foods, and little to no processed food. They are vulnerable to high rates of infectious diseases, high levels of wasting or stunting, high maternal and child mortality rates, and other factors resulting in a shorter life expectancy. Even if famines recede with the emergence of agriculture, people still experience "hunger seasons".

With urbanization, globalization and trade liberalization, food systems become more interconnected, with longer and more complex food supply chains (see Chapter 4). These food systems offer many consumers the possibility to access new and more diverse foods all year long, protecting them against seasonal shortfalls, expanding their food choices and thus modifying their dietary preferences. However, some marginalized and vulnerable groups still have limited food choices, because of their gender, ethnic or socio-economic status, or because of the lack of recognition of their rights to land, territories and natural resources (including seeds). Some communities, living in remote rural areas, in urban slums or in isolated areas (e.g. in mountains, forests, landlocked countries or small islands) might have a limited access to a diverse and quality diet due to dysfunctional food supply chains that are unable to deliver perishable nutrient-rich foods such as fruits, vegetables and ASF. Rural communities and many indigenous peoples produce food for their own consumption, but even subsistence farming communities also produce food to sell. Food production can therefore be associated with income, among other factors. For some communities, local traditional foods (e.g. local leafy green vegetables, agroforestry foods, legumes and pulses, traditional grains and tubers) remain important components of the diet but might not be sufficient to fill nutrient gaps.

In mixed and modern food systems, lifestyles change,[29] greatly influenced by urbanization and income growth. Urbanization can also causes demographic and technological changes such as more women entering the labour force and new infrastructure that opens new opportunities (Seto and Ramankutty, 2016). Urbanization, along with the associated changes in income and lifestyle, also affects food preferences. An increased demand for food, especially ASF, is expected (Ranganathan *et al.*, 2016; HLPE, 2016). Urban food consumers also have increased demand for processed and convenient foods, street food and fast food (IPES-Food, 2017) and not only tend to eat more but also engage in less physical activity (Kearney, 2010), which has important implications for obesity and NCDs.

When incomes rise, dietary patterns shift to include more ASF as seen in many countries, ranging from China to Brazil – the exception being India, where increases in income do not necessarily trigger increased demand for meat protein, mainly for cultural reasons (Timmer *et al.*, 1983; Peter, 1981; Gaiha and Young, 1989; Tilman and Clark, 2014). In developed countries with already higher incomes per capita, demand for ASF is higher compared with the less affluent nations (Tilman and Clark, 2014).

These changes in diet and activity patterns coincide with reduced prevalence of undernutrition and infectious diseases, but also with increased rates of overweight and obesity and emergence of NCDs. The shift towards obesity and NCDs described in the epidemiological transition[30] is partly due to changes in diets and energy expenditure (Popkin, 2006a). People also start consuming processed and highly-processed foods that have a longer shelf-life, that are more affordable, convenient and easy to cook, but that can have negative impacts on health (PAHO/WHO, 2015; Moreira *et al.,* 2015; Monteiro *et al.,* 2017; Moubarac *et al.,* 2017).

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[28] Demographic transition refers to the transition from high birth and death rates to lower rates as a country or region develops from a pre-industrial to an industrialized economic system.

[29] People migrating to peri-urban and urban centres are becoming less dependent on manual labour and more sedentary.

[30] The epidemiological transition is a phase of development witnessed by an increase in population growth rates brought about by medical innovation in disease mitigation and a shift from infectious diseases to NCDs, followed by a re-levelling of population growth from subsequent declines in fertility rates.

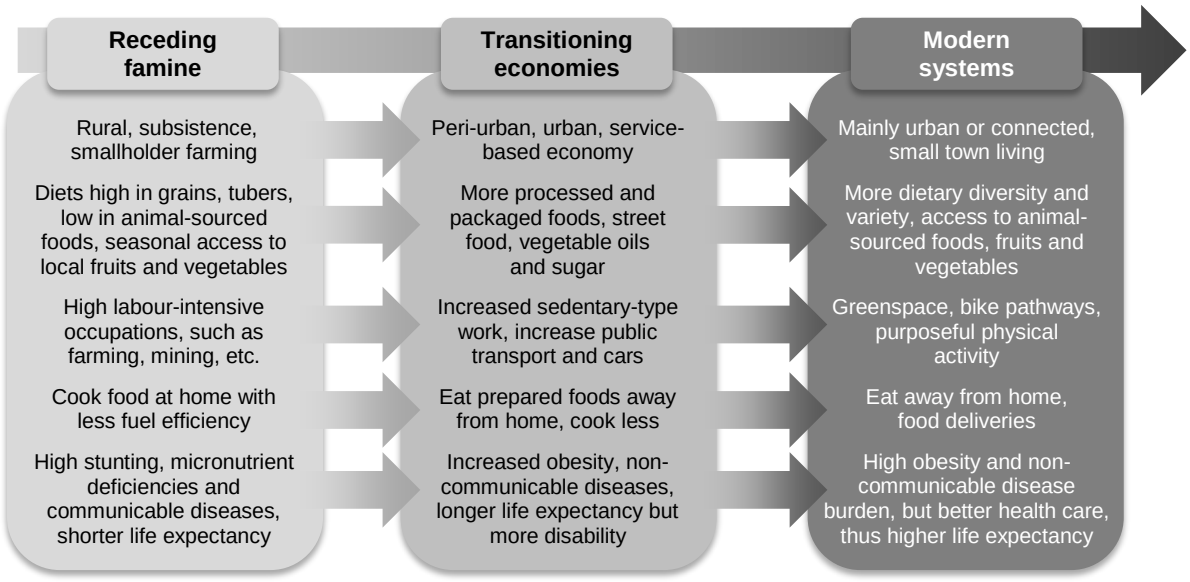
Changes in diet have been driven by economic development, the availability of foods and the cost of those foods. For instance, as the cost of vegetable oils and fats has decreased and their availability has increased, there has been a higher consumption of these fats among low-income countries (LICs) (Drewnowski and Popkin, 1997). Diet structure has also changed in terms of the increase in sugar levels in the diet (Drewnowski and Popkin, 1997), as well as the addition of other components that make foods more palatable and shelf stable. With changes in economic patterns, people are also becoming more sedentary and their energy expenditure is changing, which further contributes to the epidemiological transition (Popkin, 2006a).

In the final transition phase, behavioural change begins to reverse the negative tendencies of the preceding patterns, although currently this is rare, even in HICs. Here, people are more concerned with their health, and consciously reduce their consumption of processed foods and increase their levels of physical activity, which facilitates healthy aging. These changes may be due to increased education or may occur out of necessity in the case of people who suffer from diet-related NCDs themselves or whose close relations are touched by them. A range of factors (including urbanization, economic growth, technical change and culture) drives the changes (Popkin *et al.*, 2012). In addition, consumption of staple grains, which make up a large part of diets, is changing – with significant transitions from rice to wheat in China, millet to rice in West Africa. In Western cultures, there is also an emerging demand for exotic grains such as quinoa, and teff (Teuber *et al.,* 2016; Drew *et al.,* 2017; Mathew and Singh, 2016).

The effect of the nutrition transition on the overall quality of the diet is mixed. Countries with a more traditional, rural food system are generally associated with higher rates of stunting, underweight and micronutrient deficiencies, yet lower rates of overweight and obesity and NCDs (IFPRI, 2015a). More industrialized modern food systems, by contrast, are associated with lower rates of undernutrition but also higher rates of overweight, obesity and NCDs.

These patterns do not indicate a certain fate as countries transition. There are ways to bypass the unhealthy aspects of these patterns and, for LMICs, it is possible to not go down the same course as HICs have gone through. Nevertheless, it will take a concerted effort to avoid the detrimental impacts that many HICs have suffered with changing food systems, urbanization and their subsequent health outcomes.

Figure 10 The nutrition transition



Source: Adapted from Drewnowski and Popkin (1997).

3.1.3 Projected future dietary trends and sustainability

If current trends in food consumption continue, food systems will be unable to deliver the high-quality diets essential for reducing hunger and obesity rates worldwide in the next two decades: undernutrition, based on total calorie availability, will see only moderate reductions in Asia, while caloric deficiency will remain stagnant in Africa through 2030 (GloPan, 2016a). The increasing awareness of global challenges and of the emergence of systemic risks leads more and more stakeholders to engage in global analysis of food systems and foresight exercises.[31]

At the global level, food systems produce enough food, yet malnutrition exists in almost every country (Popkin *et al.,* 2012). Esnouf *et al.* (2013) call for transformations and breakthroughs in food systems to limit their negative impacts on nutrition, on health and on ecosystems and to make them more sustainable. Forecasting models produced by FAO and the GloPan indicate that any adoption of improved dietary profiles following WHO recommendations will require country-specific policy adaptations in order to slow increases in both hunger and obesity rates by 2050 (GloPan, 2016a).

With incomes and urbanization projected to increase with time, their influence on global diets will increase. It is projected that by 2030, some three billion more people will enter the global middle class, while more than two-thirds of the global population will live in cities by 2050. These developments will generate increased demand for, and consumption of, energy, and also of certain foods, including ASF, edible oils and processed foods – with increased demand for take-away foods as well, and for eating food outside the home (Ranganathan *et al.*, 2016).

Fruits, vegetables and pulses are likely to face obstacles to both production and distribution (GloPan, 2016a). Considerable incentives for farmers, along with other policies, are necessary to alter the trajectory of projected low vegetable and pulse production (Brown-Paul, 2014).

The largest growth in sales of medium- and highly-processed foods has occurred in LMICs, while sales are estimated to remain stable in HICs (IFPRI, 2014). Most of the projected increase in sales of processed foods will occur in East Asia, including highly populous MICs such as China and Indonesia (GloPan, 2016a).

Defining an optimal level of ASF consumption is a challenge considering the complex impact of ASF on health and nutrition status. While all ASF contain unique packages of highly bio-available nutrients, certain ASF make significant contributions of key nutrients, such as calcium in dairy, zinc and iron in meat and omega-3 fatty acids in oily fish. Diets low in ASF often result in deficiencies in iron, zinc vitamin A and vitamin B_{12} (Allen, 2012). The key micronutrients present in ASF, except vitamin $B_{12,}$ are also present in plants but their density and bio-availability is higher in ASF, making them an important source of nutrients. The specific needs of vulnerable groups should be considered when making recommendations regarding ASF consumption. The nutrients in ASF are especially important for young children, pregnant and lactating women, as well as for people suffering from malnutrition. ASF consumption is associated with health and developmental benefits in children in both LICs and HICs (Gibson, 2011; Allen, 2012). “Milk consumption is especially associated with stunting prevention while meat consumption is considered to contribute to cognitive development (Darapheak *et al.*, 2013; Rawlins *et al*., 2014; Hoddinott *et al*., 2015).

Although many countries (especially in Asia) are shifting from plant-based diets to more ASF (Keats and Wiggins, 2014), access to ASF by the poorest remains limited. This limitation affects health because ASF are more concentrated sources of nutrients (Dewey and Adu-Afarwuah*,* 2008).

Consumers in LICs often lack access to ASF, while HICs may overconsume ASF such as meat (GloPan, 2016a). Significant increases in the consumption of meat, fish and dairy and other ASF are projected in developing countries, with mixed results on nutrition: while LICs are likely to struggle to increase ASF consumption to the levels necessary for reversing micronutrient deficiencies, MICs and HICs risk overconsuming ASF with negative impacts on health and nutrition status (Alexandratos and

[31] In a recent foresight exercise called “MOND’alim 2030”, the French Ministry of Agriculture identified six patterns for the current globalization of food systems: (i) a globalization and a simultaneous diversification of feeding behaviour; (ii) an increasing dependence on international trade but no global market; (iii) the consolidation and transformation of the agro-industrial paradigm, together with a globalization of alternative models; (iv) the planetary consciousness of global challenges and the emergence of systemic risks; (v) the multiplication of stakeholders, the hybridization of their status and the proliferation of their interactions; and (vi) a multi-lateralism in crisis and an increasingly hybrid and fragmented governance (see http://agriculture.gouv.fr/mondalim-2030-un-regard-prospectif-sur-la-mondialisation-des-systemes-alimentaires-analyse-ndeg-100).

Bruinsma, 2012; HLPE, 2016). Reversing such trends remains a significant concern, including for the sustainability of ASF supply (HLPE, 2016).

A number of recent literature reviews summarized the environmental impacts of dietary patterns (Joyce *et al.,* 2014; Auestad and Fulgoni, 2015; Hallström *et al.,* 2015; Nelson *et al.,* 2016), including three that explicitly explored health outcomes alongside environmental outcomes (Aleksandrowicz *et al.,* 2016; Payne *et al.,* 2016; Perignon *et al.,* 2016). These reviews found that dietary patterns that replace ASF with plant-based alternatives confer the greatest environmental benefits. In their review of 210 scenarios extracted from 63 studies, Aleksandrowicz *et al.* (2016) found that vegan diets were associated with the greatest reductions in GHG emissions and in land use, and vegetarian diets with the greatest reductions in water use. Diets that replaced ruminant meat with other alternatives, such as fish, poultry and pork, also show reduced environmental impacts, although less than plant-based alternatives (Auestad and Fulgoni, 2015; Hallström *et al.,* 2015; Aleksandrowicz *et al.,* 2016).

However, the environmental benefits of dietary patterns do not consistently correlate with health benefits. In general, many studies report reductions in all-cause mortality and in the risks of cardiovascular disease, colorectal cancer and diabetes mellitus for more sustainable dietary patterns (Aleksandrowicz *et al.* 2016). However, these findings have been largely heterogeneous and are often not statistically significant (Payne *et al.* 2016). As such, recommendations of sustainable diets can be particularly problematic, especially in low- and middle-income countries that already struggle with nutrition transitions and micronutrient deficiencies.

According to Perry and Grace (2015), there must be concerted efforts to reduce ASF consumption in HICs, discourage overconsumption in growing economies experiencing new wealth, and increase access to high nutrient ASF for the poorest nations and vulnerable groups. In an interconnected, globalized food system, balancing the fostering of human health with environmental stewardship presents significant policy challenges (Whitmee *et al.,* 2015).

3.2 Diets of vulnerable groups

The diets of some specific groups deserve particular attention because, as shown in Chapter 2, those groups have higher dietary needs and are more vulnerable to malnutrition in all its forms. However, there is a need for more disaggregated dietary data to better understand how and where dietary patterns of those vulnerable groups are fluctuating with the view to improve their FSN status.

Young children

Diets of young children are particularly important because, as shown in Chapter 2, the quality of nutrition in the first 1 000 days impacts adult health, body composition and subsequent productivity (Black *et al.,* 2013b).

Exclusive breastfeeding is the optimal form of infant feeding up to the age of six months. Yet globally, less than 40 percent of infants are exclusively breastfed for six months (Victora *et al.,* 2016). Instead, many mothers practise mixed feeding (i.e. the provision of foods and liquids together with breast-milk) when their infants are in their first six months of life. This is often a result of caregivers' perceptions regarding the supply and quantity of breast-milk, as well as of cultural norms that encourage the early introduction of foods (Allen *et al.,* 1986; Balogun *et al.,* 2015). Mixed feeding is associated with increased morbidity and mortality of infants, and approximately 11 percent of infant deaths can be attributed to suboptimal breastfeeding practices (Black *et al.,* 2013b).

Interventions by private companies to influence policies for infant and young child feeding (IYCF) can represent a direct conflict of interest that sometimes also contravenes established laws. The global strategy for IYCF calls on commercial enterprises: (i) to meet the quality and safety standards set by CODEX Alimentarius and CODEX Code of Hygiene Practice for Foods for Infants and Children; and (ii) to ensure that conduct at every level conforms to the International Code of Marketing of Breast-milk Substitutes. Nevertheless, the underlying decision-making process may give the infant food industry undue influence (Richter, 2005) (**Box 9**). The 1981 International Code of Marketing of Breast-milk Substitutes and subsequent World Health Assembly (WHA) resolutions remain underenforced, despite the wide recognition that exclusive breastfeeding for the six first months – and continued breastfeeding, combined with safe and adequate complementary foods, up to the age of two years old or beyond – is the optimal way of feeding infants, and reduces the risk of obesity and NCDs later in life (De Schutter, 2011).

For infants and young children aged 6–23 months, WHO recommends that breast-milk consumption should continue, complemented by the consumption of foods that are sufficiently energy- and nutrient dense and diverse to promote optimal growth (WHO, 2002). This is because, after six months, breast-milk is still protective against common communicable diseases, such as diarrhoea, but is insufficient to meet a child's energy and nutrient needs (UNICEF, 2016b). In many LICs, the diets of young children are dominated by cereal-based porridges that lack the necessary micro- and macronutrients to support a child's growth (Dewey, 2013). ASF and fortified plant-based alternatives are often recommended as complementary foods for children because they are rich in nutrients, including iron and zinc, which are absent from breast-milk (Dewey, 2013). Nutrient density is particularly important for children, given the small size of their stomachs (UNICEF, 2016b). It is extremely difficult for children to meet their nutritional needs if their families do not have sufficient income to purchase, and also the time and skills, to prepare a diverse and safe diet.

Box 9 International Code of Marketing of Breast-milk Substitutes

In 1979, WHO and UNICEF hosted an international meeting that called for the development of an international code of marketing, as well as action on other fronts to improve infant and early child-feeding practices.

The WHO and UNICEF International Code of Marketing of Breast-milk Substitutes was adopted in 1981 by a WHA Resolution.[32] The international code bans all promotion of bottle-feeding and sets out requirements for labelling and information on infant feeding. Any activity that undermines breastfeeding also violates the aim and spirit of the Code. The Code and its subsequent WHA Resolutions[33] are intended as a minimum requirement in all countries. Baby food companies may not:

- promote their products in hospitals, shops or to the public;
- give free samples to mothers or free or subsidized supplies to hospitals or maternity wards;
- give gifts to health workers or mothers;
- promote their products to health workers – and any information provided by companies must contain only scientific and factual matters;
- promote foods or drinks for babies; or
- give misleading information.

Box 10 Complementary feeding indicators

Minimum dietary diversity (MDD): Proportion of children 6–23 months of age who receive foods from four or more food groups.[34] Dietary diversity is a proxy for the adequate micronutrient density of foods. Dietary data from children 6–23 months of age in ten developing country sites have shown that consumption of foods from at least four food groups on the previous day would mean that, in most populations, the child had a high likelihood of consuming at least one ASF and at least one fruit or vegetable, in addition to a staple food.

Minimum acceptable diet (MAD): Proportion of children 6–23 months of age who receive a minimum acceptable diet (apart from breast milk). Because appropriate feeding of children 6–23 months is multi-dimensional, it is important to have a composite indicator that tracks the extent to which multiple dimensions of adequate child feeding are being met. The MAD indicator combines standards of dietary diversity and feeding frequency with breastfeeding status. The indicator thus provides a useful way to track progress of simultaneously improving the key quality and quantity dimensions of children's diets.

Source: WHO (2010c).

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[32] (WHA34.22) in 1981: http://www.who.int/nutrition/topics/WHA34.22_iycn_en.pdf See also: https://www.unicef.org/nutrition/files/nutrition_code_english.pdf

[33] http://ibfan.org/art/WHA_resolutions-from-code-essentials.pdf

[34] The food groups are: 1. grains, roots and tubers; 2. legumes and nuts; 3. dairy products (milk, yoghurt, cheese); 4. flesh foods (meat, fish, poultry and liver/organ meats); 5. Eggs; 6. vitamin-A rich fruits and vegetables; 7. other fruits and vegetables.

Two indicators (see **Box 10**) are recommended by WHO for assessing the diet quality of infants and young children: the percentage of 6–23-month-olds who attain a minimum dietary diversity (MDD) and the percentage who attain a minimum acceptable diet (MAD) (WHO, 2010c). For LMICs where data are available, only 28 percent of infants achieve MDD, and only 15 percent consume a MAD (IFPRI, 2014). However, the variation across countries is wide for both indicators – between 5 and 90 percent and between 3 and 72 percent, respectively. Dietary counselling to mothers may be effective in reducing the consumption of energy-dense foods among infants, and is helpful in improving early dietary habits (Vitolo *et al.,* 2012).

Adolescent girls

The nutritional status of adolescent girls is at risk due to rapid growth and the loss of nutrients through the onset of menstruation. Adolescent girls have increased nutrient needs, and require balanced diets with adequate amounts of iron, folate, calcium and zinc (Salam and Bhutta, 2015). However, there is often low energy intake and insufficient micronutrient intake in this age group (Ochola and Masibo, 2014).

Adolescents' diets across different regions are often characterized by limited dietary diversity, and are predominantly cereal-based, with limited intake of fruits and vegetables (Ochola and Masibo, 2014; Elliot *et al.,* 2015). In many urban areas, they are also characterized by increased consumption of high-energy snacks and beverages (Ochola and Masibo, 2014). Elliot *et al.* (2015) undertook a systematic literature review to assess the quality of diets of adolescent girls, aged 10–20 years, in a wide range of LMICs. The study evaluated the adequacy of macro- and micronutrient intakes with regard to FAO and WHO estimated average requirements. They found that "prevalence of inadequacy tends to be above 50 percent for iron, zinc, calcium, vitamin D, folate, thiamine and riboflavin"– micronutrients that are all vital for the good health of girls and young women, and for pregnancy outcomes for young mothers and babies.

A number of social and cultural factors influence the diets of adolescent girls, from issues related to body image in some countries, to early marriages and social standing in others. Adolescence is a time when independent food habits are formed (Salam and Bhutta, 2015), and unhealthy diets can send young girls onto a trajectory that may adversely impact their lives into adulthood.

Women

Women have increased dietary needs due to menstruation, pregnancy and lactation. However, maternal malnutrition is not closely or systematically tracked, despite its consequences on women and their children (Black *et al.,* 2013b), and few countries collect internationally comparable data on the quality of women's diets.

As seen for adolescents and young children, women of reproductive age often do not consume adequate quantities of micronutrients (Arimond *et al.,* 2010) (such as vitamin A and iron), even when their diets meet individual energy (kilocalorie) needs. For instance, demographic and health survey data for six sub-Saharan countries show that most women report that they consume starchy staples, but less than 50 percent report having consumed legumes and nuts, vitamin A-rich fruits and vegetables, dairy or eggs the day before being questioned (Kothari *et al.,* 2014).

This is probably exacerbated by social factors, whereby the allocation of food within households might limit women's access to the foods of higher nutritional quality. Food allocation patterns are often disparate, and women's (and their children's) intake – and particularly their intake of ASF – is, in some settings, often based on their economic contribution and social valuation (Gittelsohn and Vastine, 2003). Men often have superior access to fats, protein and micronutrient-rich foods than women, while both sexes have equal access to staple foods (Messer, 1997). The social standing of women impacts nutritional outcomes and leads to micronutrient deficiencies, overweight and obesity in women, especially in view of the demands and constraints placed upon them by their domestic and work responsibilities. It can also have intergenerational consequences.

Indigenous peoples, the rural poor and rural migrants

In many parts of the world, the rural poor and rural migrants are still often susceptible to deep issues of undernutrition. They are also increasingly affected by overweight and obesity. For many rural populations and indigenous peoples, the revitalization and *in situ* protection of local traditional foods and their associated knowledge systems is essential to fight their malnutrition, preserve their local food systems and limit de-investment in rural areas.

Migration from rural areas to cities has led to substantial changes in diet, followed by large increases in diet-related chronic diseases. Similarly, migration within countries is believed to affect the diets of migrants and those of their communities of origin and destination: migrants to urban areas tend to adopt urban dietary patterns (Popkin, 1993).

3.3 Territorial influence of diets

While national food supply trends do not bode well for diets, there are some examples of territorial, regional and local food systems that are culturally based and have been important in influencing diets and reflecting and sustaining ways of life. Studies of the nutrient content of biodiverse foods, and of traditional food systems and associated knowledge systems of indigenous peoples, have generated new insights about indigenous peoples and their landscapes, diets and nutrition status over generations. This dietary landscape has changed dramatically in the past century.

There are other dietary patterns in the modern era whose nutrition and health impacts have been documented, such as the Nordic diet (Poulsen *et al.,* 2015) and the Japanese diet (Willcox *et al.,* 2009). The Mediterranean diet – one of the most widely studied diets – has not only elements of what is considered a healthy diet, but also lifestyle and socio-cultural elements that could be considered sustainable (**Box 11**).

Box 11 The Mediterranean diet: a model of a sustainable diet

Research has consistently shown that certain dietary patterns, such as the Mediterranean diet (MD), play a key role in chronic disease prevention. Ever since Keys (1995) initiated his studies on the MD, most of the research done focused on cardiovascular disease (CVD) risk factors, and particularly on coronary heart disease (Nestlé, 1995). At the end of the last century large observational cohorts were conducted to increase the evidence of other diseases' occurrence. Prospective epidemiological studies and some clinical or community trials, such as the PREDIMED study (*Prevención con dieta Mediterránea:* Prevention with Mediterranean diet), have exponentially increased the level and quality of the evidence around the MD in recent decades (Serra-Majem *et al.*, 2006; Sofi *et al.*, 2010).

The PREDIMED study is a multi-centre trial conducted in Spain (Instituto de Salud Carlos III) and financed by the Spanish Government. It evaluates a sample of 7 457 individuals at high cardiovascular risk, randomized into three groups: two MD groups supplemented with either extra virgin olive oil (EVOO) or tree nuts (almonds, hazelnuts, walnuts), and a third group with a low-fat diet following the American Heart Association (AHA) guidelines. This study showed a 30 percent relative risk reduction in CVD incidence among high-risk people, initially free of CVD, in both MD groups (Estruch *et al.*, 2013). The PREDIMED study showed, in the MD-EVOO group, reduced risks of incidence of many CVD and other diet-related diseases: arrhythmias being reduced by 38 percent; peripheral artery disease by 70 percent; diabetes by 40 percent; invasive breast cancer in women by 62 percent; and abdominal obesity or abdominal fat being decreased by 10 percent.

As a plant-centred dietary pattern that admits moderate to low amounts of ASF, the MD seems to be a model of a sustainable diet that could address both health and environmental concerns (Sáez-Almendros *et al.*, 2013; HLPE, 2016). In addition, the MD should be understood not only as a set of foods but also as a cultural model that involves the way foods are selected, produced, processed and distributed. The MD is a cultural, historical, social, territorial and environmental heritage that has been transmitted from generation to generation for centuries, and is intimately linked to the lifestyles of the Mediterranean peoples throughout their history. Since 16 November 2010, the MD has been inscribed into UNESCO's Representative List of Intangible Cultural Heritage of Humanity (Dernini and Burlingame, 2011).

The PREDIMED trial provided a sound evidence base to influence FBDGs worldwide: in developed countries, the low-fat option has been definitively replaced, and the focus has shifted to the quality rather than the quantity of dietary fats (Martínez-González *et al.*, 2015; Salas-Salvadó *et al.*, 2014).

Sources: Dernini and Burlingame (2011); Estruch *et al.* (2013); Nestlé (1995); Martínez-González *et al.* (2015); Sáez-Almendros *et al.* (2013); Salas-Salvadó (2014); Serra-Majem (2006); Sofi *et al.* (2010); HLPE (2016).

Globally Important Agriculture Heritage Systems (GIAHS) are defined by FAO as “remarkable land use systems and landscapes which are rich in globally significant biological diversity evolving from the co-adaptation of a community with its environment and its needs and aspirations for sustainable development” (FAO, 2002). They have developed over millennia in every part of the world. They reflect the indigenous knowledge systems and cultures of food producers and their place-based relationship with nature. These traditional agriculture and food systems succeeded and endured because of a fundamental understanding of the ecosystem and a sustainable management of natural resources.

Despite these important benefits, GIAHS are threatened by loss of natural resources, modernization, urbanization and globalization. Since 2002, FAO has been working to conserve GIAHS through an initiative that aims to identify existing systems and promote awareness of these systems and their importance among international organizations, governments and the public. The initiative also aims to support policies and incentives that benefit GIAHS and increase farmer incomes by paying farmers for ecosystem services, ecolabelling and ecotourism (Koohafkan and Cruz, 2011).

The GIAHS Partnership Initiative was developed by FAO and presented at the World Summit on Sustainable Development in Johannesburg, South Africa, in 2002.This UN Partnership Initiative, with FAO, UNESCO and UNEP as the most active agencies, aims to identify, support and safeguard these food systems, recognizing their importance for livelihoods, biodiversity, landscapes, knowledge systems and cultures around the world (FAO, 2016c).

3.4 The role of income on diets

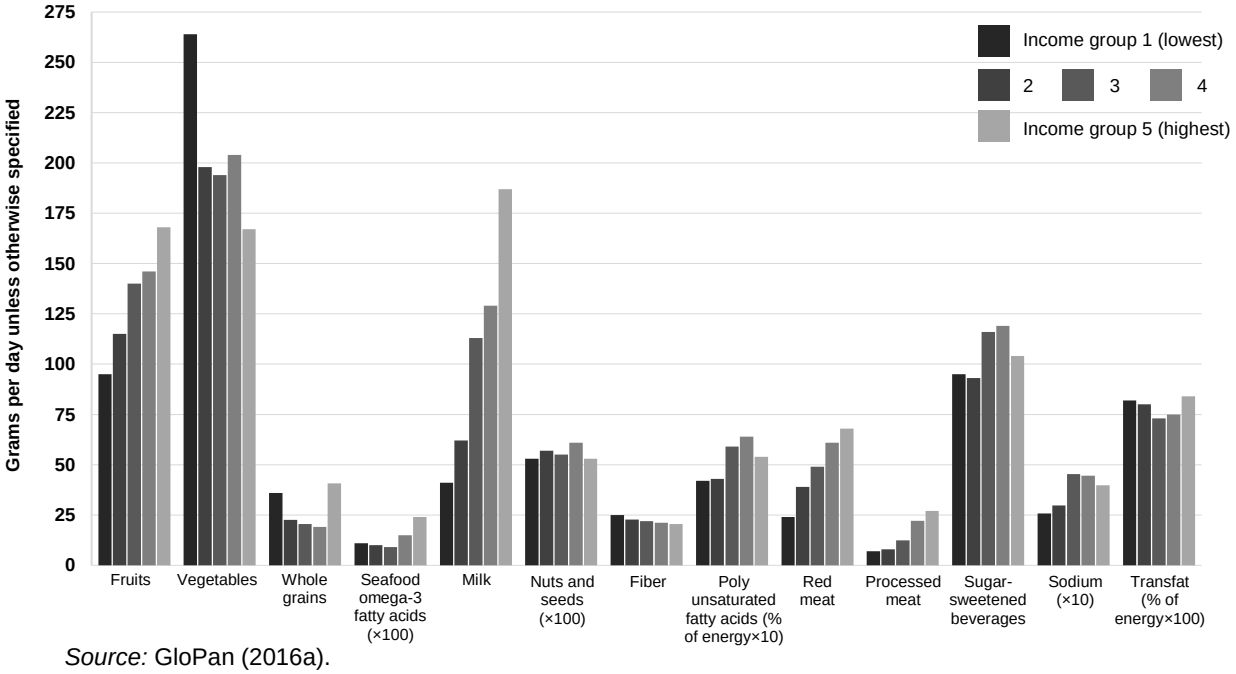
Income plays an essential role in reducing malnutrition (Smith and Haddad, 2015). Rising incomes may facilitate access to more diverse and nutrient-rich foods and at the same time to more energy-dense, nutrient-poor foods (Mayén *et al.,* 2014). **Figure 11** illustrates this positive correlation existing between national income and consumption of both “healthy” and “unhealthy” food items. For example, as national income increases, the consumption of fruits, seafood and milk tends to increase, as does the share of polyunsaturated fats in the diet. Vegetable consumption declines, accompanied by decreases in fibre intake. Consumption of red meat and processed meat, as well as consumption of SSBs and sodium also increase. The consumption of trans fats stays constant because this component is slowly being removed from processed foods and the food supply overall.

Evidence from mainly HICs indicates that healthier diets tend to be more expensive; however, in a meta-analysis, the price difference for different foods was mixed, with healthier diets costing about USD 1.50 more per day (Drewnowski and Specter, 2004; Drewnowski, 2004; Rao *et al.*, 2013). Studies have shown that diets of lesser nutritional quality cost less per calorie than healthy diets, and that these diets are usually consumed by groups of lower socio-economic status. While some nutrient-dense foods are available at low cost, they are not always culturally acceptable to consumers, and most low-income consumer budgets are insufficient to meet nutritional needs (Darmon and Drewnowski, 2015).

Imamura *et al.* (2015), in their aforementioned study on 187 countries, also found that not only are higher national incomes associated with higher consumption of “healthy” food items but also with a substantially increased consumption of “unhealthy” food items, indicating that the links between socio-economic status and diet quality are far more complex than commonly assumed. They finally argue that this complex correlation between income and diet quality might be minimized or hidden in studies that examine only overall dietary patterns that aggregate both “healthy” and “unhealthy” food items.

Increases in food prices affect the poor particularly harshly because they spend a higher proportion of their budget on food, with poor households in developing countries spending 50–80 percent of their income on food (FAO, 2011a). Poor people in LMICs often have highly cereal-based diets with inadequate provision of ASF, fruits and vegetables. With income growth, shifts in diets from these traditional staples, coarse grains, roots and tubers to diets that are more diverse and include vegetables, fruits and ASF often occur (UNEP, 2016; Alexandratos and Bruinsma 2012; Kearney, 2010). However, income growth is also concomitantly associated with increased consumption of processed and packaged foods (GloPan, 2016a).

Figure 11 Consumption of foods and other diet components by national income group, 2013



Source: GloPan (2016a).

A prospective cohort study that used an epidemiological survey of 153 996 adults, aged 35 to 70 years, from 628 urban and rural communities in three HICs, seven upper-middle-income countries, three lower-middle-income countries, and four LICs found that in wealthier countries, red meats and fried foods are more commonly consumed, whereas in the poorer countries, fruits and vegetables were generally not affordable (Teo *et al*., 2013). Miller *et al.* (2016) evaluated fruit and vegetable consumption between 2003 and 2013 in 18 countries ranging from high- to low-income. They found that consumption of fruits and vegetables, although positively correlated to national and household income, remains low worldwide and is associated with low affordability of fruit and vegetables, in particular for poor households in LMICs or in rural areas.

However, the results of a national representative sample of the Brazilian population exemplify how people in LMICs still have real possibilities of preserving their health-protective eating habits. The study showed that natural or minimally processed foods and culinary preparations made with these foods still made up almost two-thirds of the total dietary energy intake in Brazil. Rice and beans alone made up almost a quarter of total dietary energy, followed by beef or pork (red meats), chicken, milk, roots and tubers (mostly cassava and potatoes), fruits, fish, vegetables and eggs (Brazil, 2014).

3.5 Conclusion

Changes in diets have both positive and negative nutrition, health, environmental and socio-economic consequences. There are many influencing factors that are driving these changes including urbanization and incomes. Studies of food systems adapted to their local context and of the associated traditional knowledge built up over millennia can provide new insights and pathways towards more sustainable diets and food systems. The next chapter delves into the macro drivers of food system changes that are influencing diets and nutrition outcomes.

4 DRIVERS OF FOOD SYSTEM CHANGES

There are many drivers that impact the functionality of food systems and their ability to deliver healthy and sustainable diets. This chapter identifies five main categories of drivers of food systems that influence diets and nutrition outcomes.

4.1 Biophysical and environmental drivers

As shown in previous HLPE reports, food production is heavily dependent on natural resources and ecosystem services. Climate change and variability, as well as more severe and frequent natural disasters such as floods and droughts, will impact health, productivity and resilience of ecosystems, communities and households, particularly of the most vulnerable. Food systems need to adapt to climate change and can make a significant contribution to its mitigation.

4.1.1 Natural resources and ecosystem services

Food systems, and the influence they exert on diets and nutrition, are dependent on natural resources and ecosystems (Pinstrup-Andersen, 2013). Food systems depend on ecosystem services that provide benefits not only for the overall nutrient recycling system but also for human health (MA, 2005; CBD, 2016). Food has always been identified as an ecosystem service; more recently, the concepts of nutrients in food and whole diets have also been identified as ecosystem services (FAO, 2013b). Agriculture, which serves as the bedrock of food systems, can only be sustainable if natural resources, including water, land and soil, are well managed (HLPE, 2015, 2016). If soil lacks key nutrients, crop yields and livestock production will decrease (UNEP, 2016), which will affect diet quality and human health. Heavy metals in soil from synthetic fertilizers can also negatively impact human health.

Biodiversity, or the number of plant and animal species, as well as intra-species variety, is also critical for food security, diets and nutrition. Biodiversity is protective of crop loss from weather impacts or disease, which is especially important in the face of climate change. Different species and varieties, especially indigenous and local varieties, also offer dietary diversity and different nutrient profiles and must be protected to maintain these benefits (Swiderska *et al.*, 2011). Richness in biodiversity in a given agro-ecological area can result both in improved nutrient intakes and in improved environmental health (FAO, 2009; HLPE, 2017).

Agriculture and food systems are becoming increasingly homogeneous and dependent on a small number of "global" crops, including major carbohydrate-based cereals and oil crops (Khoury *et al.,* 2014). Agricultural practices are increasingly moving towards intensified monocultures, which may improve short-term grain yields but limit the biological diversity necessary for high-quality diets (Graham *et al.,* 2007; Negin *et al.*, 2009; Khoury *et al.,* 2014).

There is still debate on which production systems (large- versus small-scale, local versus global, monocropping versus mixed or organic versus inorganic) are the most advantageous for maximizing food availability and meeting nutritional needs while preserving the environment. *Nutrition-sensitive or -driven agriculture* "seeks to ensure the production of a diversified range of affordable, nutritious, culturally appropriate and safe foods in adequate quantity and quality to meet the dietary requirements of populations in a sustainable manner". This objective supposes an integrated approach covering all stages of the food system: from production, post-harvest handling, processing and retailing to consumption (FAO, 2016d).

According to IPES-Food (2016), there are many types of agriculture production systems on a continuum between subsistence farming and specialized industrial agriculture. On one side, in industrial agricultural systems, producers specialize either in the production of uniform species and varieties of monoculture crops or in intensive livestock farming. These systems tend to maximize yields and labour productivity through economies of scale, mechanization and external inputs such as synthetic fertilizers, pesticides and antibiotics. They can result in long supply chains. While these systems can increase yields, in the short term, they can also increase environmental damage (Foley *et al.,* 2011; Garnett *et al.,* 2013; Pingali, 2012; Tilman *et al.,* 2002, 2011).

While industrialized systems have created efficiencies, negative health consequences could stem from their dependency on chemical inputs such as fertilizers, pesticides and antibiotics to ensure high yields and prevent disease (UNEP, 2013; Gore *et al.*, 2015). Synthetic pesticides and herbicides can

provoke endocrine disruptions. In some countries, intensive livestock production systems often use antibiotics not only to treat infections but also to promote growth, which can increase antimicrobial resistance in organisms that infect humans and cause infections that are more difficult to treat (Ranganathan *et al.*, 2016). Antimicrobial resistance, associated with an overuse of antibiotics in agriculture, is likely to become one of the main global public health challenges in the coming decades (HLPE, 2016). To minimize exposure to or ingestion of these synthetic inputs downstream from agriculture, new methods of food production that optimize and reduce the use of such synthetic inputs, such as precision agriculture, must be developed and scaled-up.

Industrialized agricultural systems can also disrupt indigenous peoples' ways of life and the livelihoods of smallholders, who cannot compete with such models of food production based on economies of scale.

On the other side, subsistence farming is still practised by millions of smallholders throughout the world and may have a lower impact on the environment but can face many challenges such as low productivity and limited connection to markets (HLPE, 2013, 2016; IPES-Food, 2016).

IPES-Food (2016) promotes, as a new paradigm, the shift from those systems towards more diversified agro-ecological farming systems, which involve diversification and integration, at different spatial and temporal scales, of a wider range of plant and animal species and varieties for multiple purposes. These systems should be better adapted to local conditions, more labour and knowledge intensive, less dependent on external inputs and more on nutrient recycling. They could lead to less homogenous food products distributed through shorter supply chains (IPES-Food, 2016).

There are disagreements within the agriculture scientific community on how these different systems can be more nutrition-sensitive. Herrero *et al.* (2017) consider that mixed-landscape systems or diversified agro-ecological smallholder farming systems produce more than half the nutrients in the global food supply. They produce an array of species and varieties, including: protein-rich pulses; traditional leafy greens; underutilized and often neglected crops such as quinoa, fonio, sorghum and millet; and integrated livestock and aquaculture systems (Herrero *et al.*, 2017; CBD, 2016).

ASF are a key component of people's diets, providing protein, omega-3 fatty acids and micronutrients. However, livestock production systems, especially when on an industrialized scale, can be damaging to human health and the environment (HLPE, 2016). These impacts arise directly from the animals (e.g. wastes), the overuse of antibiotics, and indirectly from deforestation and land use for the production of animal feed (e.g. clearing habitat for feed or pasture) (IPCC, 2014; HLPE, 2016, 2017). In many agricultural contexts, however, animals are positively valued as investments, assets and sources of fertilizer and draught power (Steinfeld *et al.*, 2006; HLPE, 2016).

Harvesting wild foods from the environment, especially from natural forests, is an important component of diets, especially for indigenous peoples. These wild foods are threatened by deforestation and other ecosystem losses (HLPE, 2017). Wild plants can provide food security when crops fail, and add micronutrients to diets (Swiderska *et al.*, 2011; HLPE, 2017). In addition, more than 2 000 species of insects are eaten by over 3 000 groups in 130 countries, and the majority of these are foraged (Gahukar, 2011). These insects provide key macro- and micronutrients including protein, calcium, iron, zinc and the B vitamin series. For some groups of people, insects provide a large proportion of their dietary protein including in the Democratic Republic of the Congo, where insects provide up to 64 percent of the dietary protein for some tribes (Raubenheimer and Rothman, 2013). In Papua New Guinea, they can account for as much as 30 percent of the protein in some islanders' diets (DeFoliart, 1999). They are even more important during hunger seasons when other foods are not available. In Zambia during the wet season, caterpillars can account for up to 40 percent of the caloric intake (DeFoliart, 1999). However, cultural barriers limit insect consumption in Western countries. With globalization, "the Western attitude is important because acculturation toward Western lifestyles tends to cause a reduction in the use of insects, frequently in groups that are economically marginal, without affording the means by which the lost nutrition can be replaced" (DeFoliart, 1999). Additionally, if insect protein is replaced with meat, this is detrimental to the environment as livestock require more water and land and produce more GHG emissions than insects (FAO, 2013c).

Aquatic ecosystems, fisheries and aquaculture, are also important for diets and nutrition (HLPE, 2014b). Fish and seafood are important sources of macronutrients including protein and omega-3 fatty acids as well as micronutrients. Fish and seafood account for 17 percent of animal protein consumption worldwide, but can be the main source of animal protein in many coastal or island countries (FAO, 2013d). Across the globe, fisheries and aquaculture provide at least 20 percent of

their animal protein intake for three billion people and at least 15 percent for an additional 1.3 billion people (FAO, 2016e). For the poor, fish and seafood provide the best source of high-quality protein. Fish provide omega-3 fatty acids in the form of bio-available DHA and EPA.[35] These omega-3 fatty acids are especially important for maternal and child nutrition due to the significance of DHA for child development. Fish also provide micronutrients, including calcium, iron, zinc, iodine and vitamins A and D. This key component of diets for so many is threatened by the destruction of freshwater and marine ecosystems from climate change, pollution and overexploitation of the resource (UNEP, 2010; HLPE, 2014b).

Aquaculture has increased fish availability and contributed to meet a growing fish demand, easing the pressure on decreasing wild fish stocks (HLPE, 2014b). However, aquaculture relies heavily on inputs such as antibiotics, and currently uses 81 percent of the global supply of fish oil and 63 percent of fishmeal. This is especially true for higher-value, carnivorous species that are farmed, such as salmon (WRI, 2013). Furthermore, farmed fish can escape into open waters, and can endanger wild species through adverse ecological and genetic damage (Debruyn *et al.,* 2006; Fisher *et al.,* 2014). But advances using marine algae as a source of omega-3 fatty acids may be able to replace fish oil and meal. Also, other species such as carp, catfish and tilapia can be raised on plant-based feed (Msangi and Batka, 2015).

Interestingly, Clark and Tilman (2017) show that not only changes in production methods but also changes in consumption behaviour can have an important impact on the environment. In particular, they consider that "dietary shifts towards low-impact foods and increases in agricultural input use efficiency" would provide greater environmental benefits than mere changes between production systems from conventional to alternative systems (such as organic agriculture or grass-fed beef).

4.1.2 Climate change

The world is experiencing climate change and variability, shifting seasons and increased severity and frequency of natural disasters such as floods and droughts (Hansen, 2007). These changes are likely to have the greatest impact on the agricultural output of low-resource regions, reducing soil fertility, crop yields and forest and animal productivity (HLPE, 2012a, 2016, 2017). This may in turn result in lower incomes, reduced climate resiliency and, subsequently, decreased access to an adequate supply of nutrient-dense foods, thereby impairing the nutritional status of many low-income communities (Mason and Shrimpton, 2010). Coping mechanisms that increase resilience in the face of climate change will prove to be a grand challenge for many farmers, pastoralists, forest-dependent people and fisherfolk around the world (HLPE, 2012a, 2013, 2014b, 2016, 2017).

Climate change can exacerbate undernutrition through impacts on household food security, on child feeding and care practices, and on environmental health and access to health services (Met Office/WFP, 2012). Climate change influences what food is available and at what price, impacting overall calorie consumption as well as the consumption of vegetables, fruits and ASF. The expected increased mortality from climate change-mediated dietary changes is detailed in **Box 12**.

"Hunger seasons" are most severe when there is also unpredictable rainfall or extreme weather events (Devereux *et al.*, 2015). With climate change, seasonal droughts and monsoons will become less predictable and more severe, which will significantly impact nutritional status and infectious disease outcomes (Stanke *et al.*, 2013; Patz *et al.*, 2003). Even when predictions are accurate, climate still drives seasonal patterns of food insecurity to generate a complex series of interacting effects (Devereux *et al.*, 2013). Seasonal food insecurity can lead to low dietary diversity and concomitant micronutrient (such as iron) deficiencies (Savy *et al.*, 2006).

Increased concentrations of atmospheric carbon dioxide cause increased photosynthesis rates and increased growth. Some have argued that this will offset the reduced yields from the other effects of climate change (Müller and Robertson, 2014). The nutritional content in some foods may increase, because of carbon dioxide fertilization, but will decline in others (Smith and Haddad, 2015). Increased carbon dioxide has been shown to reduce nutritional content (in protein, as well as in iron, zinc and other micronutrients), mainly in C3 grains (e.g. wheat, barley and oats) and legumes (Myers *et al.,* 2014).

[35] Respectively, docosahexaenoic acid and eicosapentaenoic acid.

Box 12 Global and regional health effects of future food production under climate change

A recent study examining the effects of climate change on agriculture and their implications for dietary and weight-related risk factors, and associated excess mortality, was conducted in 2010 for 155 regions. The study linked the International Model for Policy Analysis of Agricultural Commodities and Trade (IMPACT) developed at IFPRI[36] to a comparative risk assessment of the impacts of changes in diets (fruit and vegetable and red meat consumption) and body weight on death due to coronary heart disease (CHD), stroke, cancer and all other causes combined. The model indicated that, by 2050, climate change would lead to a 3.2 percent per person reduction in global food availability, a 4 percent reduction in fruits and vegetables and a 0.7 percent reduction in red meat consumption. The changes would be associated with 529 000 climate-related deaths worldwide, which represents a 28 percent reduction in the number of deaths that could be avoided due to changes in dietary and weight-related risk factors from 2010 to 2050. Twice as many climate-related deaths were associated with reductions in fruit and vegetable intakes compared with those related to the prevalence of underweight.

Source: Springmann *et al.* (2016).

Climate change heightens stress for livestock (HLPE, 2016). Increasing temperatures cause direct stress, while changes in precipitation make it difficult to find water, which leads to dehydration. There may also be reduced feed availability, particularly in grass-fed systems. Minor pressures can cause animals to produce less milk or to grow more slowly, producing less meat. This reduces the calories and nutrition available for human consumption. Climate change could cause a 10 to 25 percent decrease in the production of milk (IPCC, 2014), which is an important source of nutrition for children (Marquis *et al.,* 1997). Increasing stress can also lead to the loss of animals, leading to greater decreases in food and incomes. Past droughts have resulted in as high as 20 to 60 percent losses of cattle populations in sub-Saharan Africa (FAO, 2016e). In Somaliland, Somalia, many people are dependent on livestock and recent drought has already caused ten million goats, sheep, and camels to die (Mohamed, 2017) and future droughts could be similar or worse.

Climate change also impacts fisheries through changes in ocean temperatures (along with their salinity, oxygen and acidification levels) and freshwater temperatures (along with their water levels) (Cheung *et al.*, 2010). The degradation of ocean habitat negatively impacts fisheries, reducing the availability of this nutritious food source (FAO, 2013d).

4.2 Innovation, technology and infrastructure drivers

Innovation has been a major engine for food system transformation in the past decades, and will be critical to address the needs of a rapidly growing population in a context of climate change and natural resource scarcity. Building more sustainable food systems to enhance FSN will require not only new research and new technologies, but also better access to and use of existing technologies, and developing context-specific solutions that are adapted to local ecosystems and to local socio-economic and socio-cultural conditions. The limitations and potential risks of innovation and technologies to FSN, human health, cultures, livelihoods and the environment must also be considered.

4.2.1 Innovation and technology

Innovation is a major driver of food systems and access to new technology has had large impacts on diets and nutrition (Pingali, 2012; Hueston and McLeod, 2012). The Industrial Revolution modernized agricultural production through mechanization and new breeding methods. Technologies such as food processing and preservation changed the way food could be stored and distributed, with many positive outcomes. Technological applications can also be used to grow more nutritious foods, often in ways that are more sustainable (Floros *et al.,* 2010).

New technologies are being used to very positive effect to ensure that nutrition does not “exit” the food supply chain (Fanzo and Downs, 2017). High-tech solutions are being developed regarding plant-based proteins, which are marketed as meat alternatives or imitation meat. While imitation meat, such as vegetable-based burgers (“veggie burgers”) is not new: there have been large improvements

[36] https://www.ifpri.org/program/impact-model

in taste, texture and smell, although some of these products, such as laboratory-grown meat, remain prohibitively expensive (Heffernan, 2017). There have also been technological advances in nanotechnology, 3-D printing and robotics that will impact food systems.

The need to produce increased quantities of healthier food will require innovative and responsible efforts by the actors in the world's food supply chains. While innovative technology has the potential to sustainably produce enough nutritious food to feed the planet, it also has the potential to damage human and environmental health. Public health should take a central role in determining which technologies should be deployed in pursuit of increased food production. Smaller-scale production models that use organic and agro-ecological production techniques are often based on innovation and knowledge – tapping into both scientific and traditional knowledge. The articulation of these two types of knowledge can generate both ecosystem services and natural and social capital for the communities that serve as stewards of these landscapes.

One example of such a technology that has polarized the food security world is genetic modification (GM). Is GM necessary if there is enough existing genetic diversity within a genome to find genes for needed desired traits? If there is a need for transgenic modifications, what are the most appropriate modifications (e.g. resistance to drought, flood tolerance, saline tolerance, pest resistance, improved nutrient content or higher yield)?

There is much uncertainty and a significant lack of consensus on the risks and benefits of GM with regard to its potential impacts on human health and on sustainability in its three dimensions (environmental, economic and social). At the centre of dispute is the idea that GM foods can increase crop yields and are thus necessary or at least part of the solution to feeding the world's population and staving off hunger (Klümper and Qaim, 2014). Others argue that investing in conservation and use of agricultural biodiversity is a better approach (Jacobsen *et al.,* 2013). However, beyond yields, central to the GM debate are issues such as knowledge, trust and personal values and these views are often regionally driven (Whitty *et al.,* 2013; Frewer *et al.,* 2013). Some argue that GM perpetuates "agrarian dispossession", farmers losing the control over seeds and other inputs necessary for food production that are owned by companies (Kloppenburg, 2014). Labelling of GM food is also currently being debated in many countries.

If GM is to be used, policy-makers, seed companies and plant breeders should take into consideration the context in which the crop is introduced, and should evaluate the best communication strategies to aid in fair and transparent implementation. Researchers and industry must convey both the potential benefits and the potential risks of GM themselves, with full disclosure of interests and thorough communication measures to the public (Glass and Fanzo, 2017).

More generally, the challenge is to make the best possible use of innovation and technologies to meet the needs of a growing population while also preserving natural resources, biodiversity and ecosystem health. Not only the potential but also the associated risks of innovation and technologies must be assessed and taken into consideration.

4.2.2 Infrastructure

All food, besides what people grow for their own consumption, has to be transported, across short or long distances, from where it is grown to where it is processed, distributed, sold and, ultimately, consumed. With globalization and trade liberalization, food moves longer distances. The share of agricultural production traded internationally has increased considerably, from about one-ninth in the 1960s to about one-sixth in the 2000s (Anderson, 2010). In the United States of America, food travels an average of 2 400 km (1 500 miles) before it is consumed (Pimentel *et al.*, 2008).

Food can be transported by animal, motor vehicle, rail, ship or air, but this requires infrastructure such as roads, railroads and shipping canals. These have all been improving since the industrial age (Hueston and McLeod, 2012) but quality and access to this infrastructure vary and are often limited for the rural poor. In South Sudan and Somalia, poor road infrastructure is a major barrier to food access (ACAPS, 2017). Transportation access affects food security and safety, as it is required for food to move long distances to areas of shortages to increase food security and stabilize food prices and for this to be done quickly, minimizing food-borne disease and food waste.

4.3 Political and economic drivers

Leadership as well as inclusive governance mechanisms, from global to local levels, are crucial: to invest in sustainable food systems; to design and implement guidelines, policies and programmes that strengthen food systems, improve diets and enhance FSN; and to overcome power imbalances in current food systems. Accountability and sustained commitment require significant political will. Political and economic drivers of food systems and dietary changes also include: trade and globalization; specific food policies such as food-based dietary guidelines and subsidies, food prices and price volatility; policies on land tenure and use; water and fisheries policies (see HLPE, 2014b, 2015); and geopolitical issues of conflicts and humanitarian crises.

4.3.1 Leadership

Appropriate leadership and governance mechanisms at different scales are crucial for the design, enforcement and implementation of FSN-related laws, regulations, policies and programmes (Morris *et al.,* 2008). When there is weak governance, several bottlenecks for strengthening food systems and improving nutrition emerge (Bryce *et al.*, 2008). Several studies have highlighted the role of leadership at national, regional and global levels in placing nutrition on the global development agenda and ensuring that it receives adequate investment (Shiffman, 2010; Shiffman and Smith, 2007; Nisbett *et al.*, 2015). Going one step further is accountability and sustained commitment (Nisbett *et al.,* 2014).

For those in leadership positions, many factors have to be weighed in the decisions being made about food systems, and not all of them may be visible to policy-makers. Beyond short-term responses to food prices, imports and trade may have longer-term consequences for nutrition, and too many decisions by governments as to how to structure their food systems and environments are swayed by the more prominent and powerful voices – coming from international development policy-makers, donors, agribusiness and food and beverage industries. Consumers, especially the poorest, are too often excluded from,or marginalized in the decision-making process. How to wrestle with these power struggles in food systems and what they mean for the health of consumers is still controversial. New decision-making and accountability mechanisms are needed to address these uneven power dynamics.

4.3.2 Globalization and trade

Globalization and trade have significant impacts on diets and nutrition (Montalbano *et al.,* 2015; Friel *et al.,* 2013). Every country in the world is impacted by globalization, although many people have not seen its benefits.

Globalization stimulates the nutrition transition described in Chapter 3 by changing lifestyles and living standards, and the associated dietary demands (Hawkes and Popkin, 2015). Globalization also shapes the food environment, notably through the expansion of supermarkets and hypermarkets (Qaim, 2016). The distribution and retail models created by globalization tend to provide larger population centres with more choice and higher-quality food while marginalizing more remote areas. They have also tended to exclude small-scale producers from the supply chain, although the process is highly dynamic, and there is some evidence that over time this exclusion can be addressed, as the process extends out to smaller urban centres (Reardon and Hopkins, 2006). Nonetheless, even industrialized countries struggle to serve all regions equally through private retail systems, as for instance in Canada's Northern and remote regions (De Schutter, 2012).

Globalization, by enhancing the interconnectedness of places and people, fosters the convergence of consumer preferences towards the so-called "Western" lifestyles and diets (Brunelle *et al.,* 2014). This dietary shift is associated with the increasing prevalence of overweight and obesity worldwide (Goryakin *et al.,* 2015). This may in part be because the model of food distribution and retail (sometimes called the "supermarket revolution") first extends to processed and semi-processed foods, only more slowly extending to include fresh produce.

There are multiple pathways by which trade and nutrition are linked (Hawkes, 2015). First and foremost, trade can diversify sources of food supply. It also increases competition, favouring lower-cost producers. Both these changes tend to reduce food prices for consumers. As exemplified for fish and seafood (HLPE, 2014b), international trade can put relatively richer consumers in different parts of the world in competition with relatively poorer consumers; the latter may find their local foods to be

suddenly in demand – or that their resources are in demand for export food products instead of traditional food products. This can lead to increased prices for specific foods, even if international trade is overall reducing the cost of living.

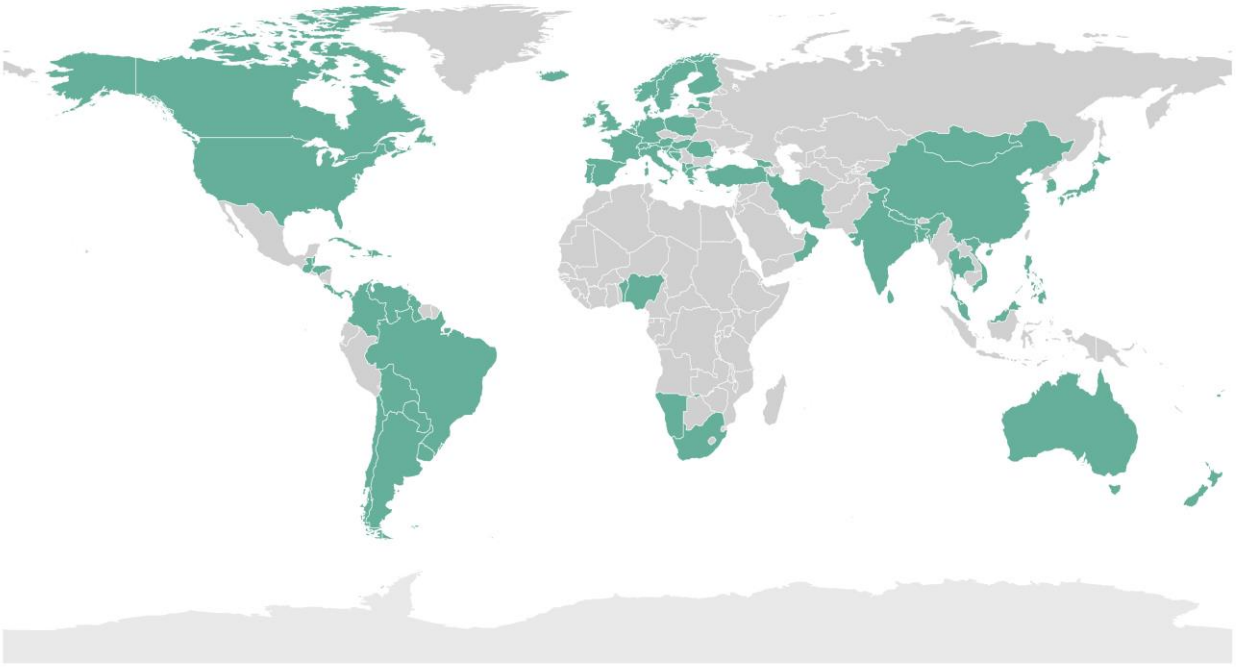
Second, trade can enhance the diversity of national diets by increasing the availability of different types of foods, and extending the number of days a year that products are available (for example, the Southern and Northern hemispheres have complementary growing seasons). Trade influences the range of foods that is available and affordable within any given country, although sometimes at the expense of local producers and traditional – often more nutritious – foods (for example, cheap rice has displaced traditional grains in many parts of urban West Africa) (Huang, 2010; Asche *et al.*, 2015). Trade may increase the choices available to households, supporting shifting preferences associated with women's increasing role in productive labour outside the household (Kennedy and Reardon, 1994). By contrast, when products such as soft drinks and highly processed snacks become cheaper, the consequences are harmful (Hawkes, 2006; Stuckler *et al.,* 2012; Schram *et al*., 2015).

Third, increased trade has been associated with rising incomes, although also with rising levels of inequality (Stiglitz and Charlton, 2005). Rising incomes are important for food security; however income disparities can pose a problem if they skew the distribution system to cater to the demands of higher-income consumers at the expense of the availability of more affordable food. Any economic change, such as increased trade openness, creates winners and losers; experience suggests that governments need to be attentive to the food security outcomes for poorer consumers (and resource-scarce producers) if they choose a policy of market opening and integration into global trade. The market on its own will not protect vulnerable groups if they do not have adequate purchasing power.

4.3.3 Food, agriculture and nutrition policies

FBDGs can act as policy levers to influence agricultural production and industry food formulation as well as the food distributed in public procurement programmes, such as school meal programmes and food assistance (Mozaffarian and Ludwig, 2015). In some countries (e.g. Brazil and Sweden), robust dietary guidelines have been created in support of public health along with sustainability goals (FAO, 2017b). It should be noted, that only 83 countries have a FBDG and, of those, many are HICs (Gonzalez Fischer and Garnett, 2016) (**Figure 12**).

Figure 12 Map showing (in dark) countries with a food based dietary guideline (FBDG)



Source: Gonzalez Fischer and Garnett (2016).

Historically, the United States of America has formulated dietary guidelines that lead to increased carbohydrate intake, increased addition of refined sugars such as high fructose corn syrup, and reformulation of products from high- to low-fat. Some argue that those dietary guidelines were correlated with an increased incidence of obesity and diabetes; however there are probably several factors that contributed to these increases (Mozaffarian and Ludwig, 2015; DiNicolantonio, 2014). This example from the United States of America has called into question the evidence base of dietary guidelines, and it has been recommended that guidelines consider the "totality of evidence", including all trials and epidemiological studies that examine foods and nutrients (Mann *et al.*, 2016).

Beyond FBDGs, many nutrition policies, including in LMICs, have been focused on multi-sectoral approaches that include not only the public health sector but also agriculture and food systems. While these policies are important in engaging the multiple sectors and potential political commitments that nutrition requires, there are issues in implementing these strategies including human resource capacity, nutrition monitoring, and governance and management of those policies (Lamstein *et al.,* 2016).

The question of whether agriculture and food subsidies impact diets and nutrition outcomes remains uncertain. First, the evidence is not straightforward in establishing causality and "the nature of the experiments needed to provide definitive evidence supporting certain policy directions is likely to be complex and potentially unfeasible" (Faulkner *et al.,* 2011). Furthermore, many agriculture subsidy programmes do not explicitly consider nutrition outcomes, as they are meant to have wider economic and political goals (Kennedy and Alderman, 1987). To better understand why answering this question remains difficult, two cases in the United States of America and Egypt are presented in **Box 13**.

Subsidies and taxes on food have the potential to influence consumption considerably and improve health, particularly when they are large (Thow *et al.,* 2010a). Currently, financial incentives favour the consumption of highly-processed, energy-rich, nutrient-poor foods since they are generally cheaper than less-energy-dense and often more nutrient-rich foods (Drewnowski and Specter*,* 2004). Taxing more nutrient-poor foods could create a financial incentive for consumers to avoid them. Studies on the effect of manipulating food prices show that consumers do respond as predicted, whether at individual or collective levels (Beydoun *et al.,* 2008).

Box 13 Impact of food subsidies on nutrition outcomes: the cases of the United States of America and Egypt

The impact of food subsidies on nutrition in the United States of America (USA) is still in debate. While studies have indicated that overproduction of corn and soy, spurred on by the country's agriculture subsidy policies, is one of the primary causes of the increased consumption and therefore, obesity among its population (Putnam *et al.,* 2002; Silventoinen *et al*., 2004), others argue that current subsidy policies in the United States of America have a mild or negligible impact on dietary patterns and obesity (Alston *et al.,* 2013; Franck *et al.,* 2013). However, when examining subsidies impacts on dietary consumption, different effects need to be examined depending on the commodity. For example, Rickard *et al.* (2013), using a detailed multimarket model, found that, all other policies remaining constant, removing subsidies on grains and oil seeds in the USA would have minimal impact on caloric consumption whereas removing all the USA agricultural policies, including barriers against imports of sugar and dairy products, would increase caloric consumption in the USA.

Energy-dense, nutrient-poor foods have become an inexpensive source of daily caloric needs throughout Egypt due to its food subsidy programme (Asfaw, 2007). Recent research indicates the programme has been a major contributor to increasing obesity rates, cardiovascular diseases and micronutrient deficiencies across all income groups (Powell and Chaloupka, 2009; Asfaw, 2006). *Baladi* bread (a traditional Egyptian staple), wheat flour, sugar and oil are estimated to encompass only 4 percent of average food expenditures, though they comprise 31 percent of the total calorie availability in Egyptian households (Asfaw, 2006). The programme does not restrict subsidies for *baladi* or wheat flour based on income, but reduced prices for sugar and cooking oil are available only for ration holders – providing low-cost, nutrient-poor cooking materials only for low-income households (Asfaw, 2007). Empirical models suggest that altering the subsidy profiles will significantly reduce welfare for the majority of the Egyptian population across both low- and middle-income groups and that a cash transfer programme or other nutrition-sensitive interventions might be more effective (Ramadan and Thomas, 2011).

4.3.4 Food prices and volatility

Changes in the relative prices of foods alter consumption behaviour (Griffith *et al.,* 2015; Dubois *et al.,* 2014; Wiggins *et al.*, 2015). When the prices of non-staple foods increase, diet quality declines (Herforth and Ahmed, 2015). Sharper reductions in the prices of unhealthy foods than of healthy foods (Wiggins *et al.*, 2015) are expected to increase the consumption of unhealthy foods.

A study in ten LMICs across 23 communities following the global food crises found that one of the ways in which people were coping was to switch to cheaper foods, often moving towards more processed and packaged foods. Further, people sought to earn more cash, and thus experienced great changes in their working lives and started making food purchases in new locations as they moved around in connection with their work. Women were doing more paid work than in the past and, with less time available to feed the family, were resorting to more convenience foods, ready-made meals and quick-cooking staples (Scott-Villiers *et al.*, 2016).

Increased food prices tend to reduce the quantity and quality of food consumed among poor households that spend a large proportion of their incomes on food (Sanogo, 2009; Swan *et al.,* 2010). Increased food prices lead to higher levels of stunting among children (Martin-Prevel *et al.*, 2000) as well as impaired growth of infants and decreased maternal micronutrient status (Gitau *et al.*, 2005). In Bangladesh, rice prices are associated positively with prevalence of undernutrition and negatively with household non-grain food expenditures (Campbell *et al.*, 2010, Thorne-Lyman *et al.*, 2010). Additionally, the impact of food prices on consumption varies according to national income: in general, in LICs the price of a fruit determines its consumption to a greater extent than it does in MICs and HICs (Miller *et al.*, 2016). Price promotions – especially "buy one, get one free" deals – are often heavily biased towards less healthy options, and clearly stimulate increased energy intake (Powell *et al.*, 2016).

HLPE (2011a) analysed how price volatility interacts with price levels to impact livelihoods and food security. However, several countries escaped the negative impact of the 2007-2008 food prices peak on nutrition because of high economic growth during the same period, often linked to these countries' dependence on primary commodity exports and the increased revenues they received while prices were higher. While it is difficult to obtain a global picture, evidence from different contexts shows that there are real negative impacts due to food inflation for people who live in or just above the poverty line (HLPE, 2011a). At the same time, these short-term effects must be set against the long-term benefits of higher returns to agriculture, which have important virtuous effects for the wider economy. This is in particular true for rural areas, where hunger and malnutrition are often concentrated: rural-urban migration is often driven by desperation rather than pulled by better economic prospects in the city. For example, higher crop prices have been shown to be associated with higher wages for landless workers that will spend most if not all their income in the local economy (Wiggins and Keats, 2014; Headey and Martin, 2016).

The HLPE has shown in previous reports the importance to consider together a mix of different policies to address the short- and long-term effects of food prices on FSN: social protection programmes that protect consumption in the short term from unexpected price spikes; price stabilization measures that prevent extreme price volatility that could disrupt investments in long-term elements of FSN (HLPE, 2011a, 2012b).

4.3.5 Land tenure

As shown in previous HLPE reports (2011b, 2013, 2016, 2017), improving access to land, through appropriate and secured land ownership and use rights, is critically important for the empowerment, material well-being, diets and nutrition of indigenous peoples, smallholders and the rural poor. For instance, a study of two villages in northern India showed that the households that owned land, being more easily able to grow feed and breed cows, consumed around twice as much milk as those that did not. As an important source of proteins, calcium, vitamins A, D and B, milk is critical for health and nutrition. Landowners were also shown to be less dependent on food aid from the government (Pritchard *et al.*, 2017). During the 2002 food crisis in Southern Africa, land and natural resource use rights in the Kafue Flats in Zambia were given to the more powerful and those with less access had lower incomes and decreased food security and food intake and this negatively impacted child growth (Merten and Haller, 2008). Access to other natural resources such as lakes and rivers for fishing and forests for hunting and foraging is also important for FSN (Merten and Haller, 2008; HLPE, 2014b, 2017).

Land ownership and use rights also provide farmers with more stability and increased access to capital, credit and loans since they can use their land as collateral, allowing them to invest more in food production. Feder and Onchan (1987) found that land ownership was associated with increased access to capital and increased land improvements in two provinces in Thailand; however, they found that land ownership was less important in a third province that had greater access to informal credit. In indigenous communities in sub-Saharan Africa, Place and Hazell (1993) found that individual land ownership was not a factor in farmer decisions about investments but that the right to use the land, especially long term, was more important. It is unclear, however, if this increased access to capital and credit translates into improvements in diets and nutrition outcomes.

It should be noted that men and women often do not enjoy the same land and tenure rights,[37] and that land ownership is not always sufficient. In India, ownership of small or fragmented land parcels that cannot support household consumption is increasing, leading most farmers to be net food buyers and decreasing the benefit of owning land for FSN (Pritchard *et al.*, 2017).

4.3.6 Conflicts and humanitarian crises

A growing number of countries are currently struggling with destabilized governments, social unrest, conflicts and humanitarian crises. Within the humanitarian community, there is an increasing acknowledgment of the impact of conflicts and protracted crises on FSN and, therefore, of the importance of integrating nutrition into any emergency response and longer-term strategies towards sustainable development.

Harmer and Macrae (2004) consider that regions and countries in protracted crises are “environments in which a significant proportion of the population is acutely vulnerable to death, disease and disruption of livelihoods over a prolonged period of time”. According to CFS (2015), “protracted crises include situations of prolonged or recurrent crises” entailing in particular: “disruption of livelihoods and food systems; increasing rates in morbidity and mortality; and increased displacements". Most of the countries currently experiencing conflict are classified by FAO as "low-income, food-deficit” and have a high incidence of undernourishment and child stunting. Complex crises have both immediate and long-term consequences for nutritional status (Egal, 2006).

The trigger for crisis may be natural, such as a prolonged drought, or human-made. It may be economic, such as a fluctuation in the price of a country’s major staple or cash crop. As well as being a consequence of conflict, food insecurity can also in itself lead to conflict (Brinkman and Hendrix, 2011; OECD, 2009; Quinn *et al.*, 2014), as is the case with rising food prices. Asia and Africa have become increasingly dependent on food imports. The 20 most populated countries in Africa are net grain importers (Hendrix, 2016). As discussed in Section 4.3.4 above, countries that are vulnerable to imported food price volatility may suffer social unrest and conflict when prices rise and governments are unable to intervene (Hendrix, 2016). According to the World Bank, over 30 countries experienced riots during the food price crisis of 2007–2008 (World Bank, 2014).

There is growing concern regarding the number of children who are displaced due to conflicts. UNICEF (2016c) estimates that there are 50 million children who have been “uprooted.” In 2015, around 45 percent of all child refugees under United Nations High Commissioner for Refugees’ (UNHCR) protection came from the Syrian Arab Republic and Afghanistan. This instability puts these children at increased risk of malnutrition due to lack of access to healthy diets and social services. “All aspects of health care, nutrition, water and sanitation, and social protection are routinely disrupted or halted altogether as children and families move or spend extended periods in displacement. Each of these can have devastating effects on individual families as well as the larger communities in which they live” (UNICEF, 2016c).

Food systems that are repeatedly put under stress by conflict tend to move from predictable food supply chains to unstable and volatile ones. Violent, armed conflict can lead to the destruction of crops, livestock, and land and water systems, as well as to disruptions in the infrastructure and human resources required for food production, processing, distribution and safe consumption (Pingali *et al.*, 2005). In South Sudan, almost 50 percent of harvests were destroyed in areas of violence (ACAPS, 2017). During conflicts, food prices often increase and people’s livelihoods are also disrupted, leading to lower incomes, and they may not be able to physically access markets.

[37] See, for example, the FAO Gender and Land Rights Database: http://www.fao.org/gender-landrights-database/en/

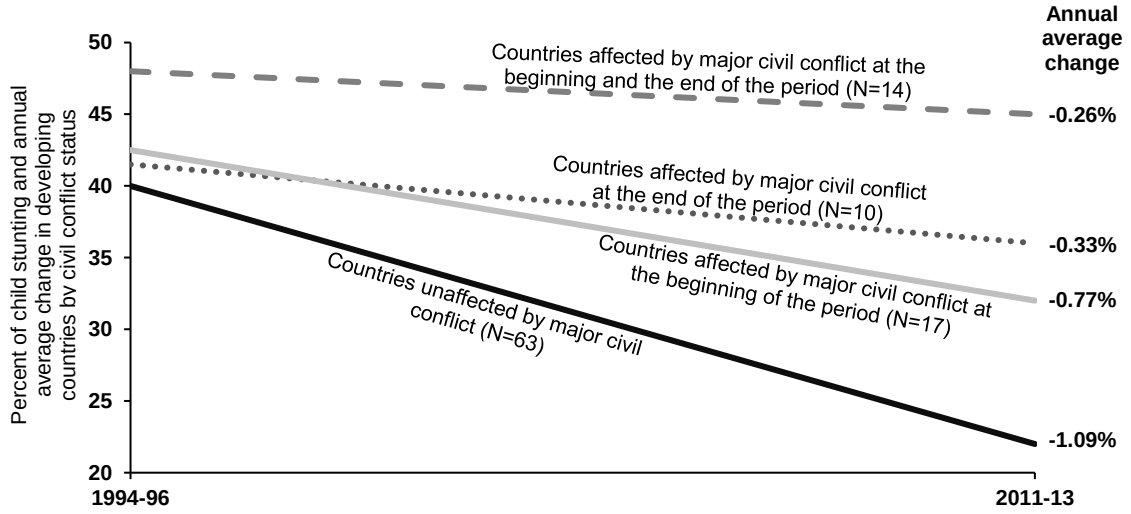
Conflicts are often a cause of acute hunger or famine (de Waal, 2015). Currently, more than 1.4 million children are at imminent risk of death from severe acute malnutrition (SAM), and over 40 million people are in need of humanitarian assistance, due to famine in South Sudan and the risk of famine in Nigeria, Somalia and Yemen. In Nigeria, the violence from Boko Haram has forced millions people to flee and to live in camps with little food or clean water (Roberts, 2017), and 4.4 million children are in need of humanitarian assistance. In South Sudan, fighting between the government and opposition forces, as well as between communities, has led to the displacement of millions of people (ACAPS, 2016; World Vision, 2017), and 6.2 million people need humanitarian assistance. In Somalia, 1.2 million children under five are acutely malnourished and 6.2 million people need humanitarian assistance because of long standing conflict and political instability, as well as significant drought, particularly in the pastoralist expanses (Mohamed, 2017). Humanitarian needs in Yemen are at their highest with over 20 million people, including around 11 million children, needing assistance (ACAPS, 2017). The crisis is not limited to these four countries as a severe drought is impacting the Horn of Africa, particularly Djibouti, Ethiopia and Kenya.[38]

There are other countries that are also at high risk of significant food insecurity and acute malnutrition including Afghanistan, the Democratic Republic of the Congo, the Syrian Arab Republic and Venezuela (Bolivarian Republic of). Some cities also experience growing racial, ethnic and poverty inequalities, including cities in the United States of America reeling from racial tensions (Baltimore, Detroit, South Chicago), as well as *favelas* and slums of Brazil, Honduras and South Africa. Food deserts, food swamps and poor nutritional status impact these communities to various degrees.

Those instigating or participating in war and conflict often use hunger as a weapon: "they use siege to cut off food supplies and productive capacities, starve opposing populations into submission, and hijack food aid intended for civilians" (Messer *et al.*, 2001). In Nigeria, Boko Haram has targeted food markets and food aid. In South Sudan, both sides of the conflict believe that food aid helps the other so they try to limit it. Aid workers are also being directly targeted in South Sudan, Somalia and Yemen (ACAPS, 2017).

Because food insecurity and malnutrition can be both a cause and a consequence of conflict, global chronic undernutrition has become increasingly concentrated in conflict-affected countries (Kramer, 2015). Conflicts cause persistent hunger (de Waal, 2015) and countries that experience longstanding conflicts have difficulty making progress on improving nutrition as shown in **Figure 13**.

Figure 13 The impact of conflict on reductions in undernutrition



Note: A country is classified as affected by major civil conflict if it experienced an average of more than 100 battle-related deaths or fatalities in nonstate conflicts or other clashes over a period of three years. N is the number of countries. Country averages are calculated based on population weights. The child-stunting rates used are the first and the last estimates taken over the period.

Source: Adapted from IFPRI (2015b).

[38] UNICEF provides on his website regular updates on famine response progress, as well as regular situation reports in affected countries. All the figures given in this paragraph are taken from the latest situations report available for each country at: https://www.unicef.org/appeals/famine.html (accessed on 19 September 2017)

While taking steps to account for nutrition in humanitarian responses is a key component, many of the larger obstacles are bound up in the politics of the conflict, and not easily untangled. There is a critical need to enhance FSN through specific policies and programmes that link emergency hunger relief interventions with a long-term strategy for sustainable development. This means breaking down the barriers between humanitarian and development work with the view to work towards a humanitarian-development continuum. There is a need to think about integrated short- and long-term approaches with the view to increase food systems' resilience using a rights-based approach. This would include: rebuilding local institutions and support networks; strengthening farmers' ability to adapt and reorganize; providing recovery measures for rural livelihoods; building on existing social protection systems or helping to create them; and supporting marginalized and vulnerable groups.

4.4 Socio-cultural drivers

Individual food choices, although deeply personal, also reflect cultures, religions and social norms, as evidenced for instance by Rozin *et al.* (2006). Culture is inherent in agri*culture*. Food is the product of agriculture so it goes without saying that food plays a powerful role in how we tie ourselves to the land and preserve our historic social traditions and culture. Food systems are consistently shaping our culture and traditions and vice versa.

Gender relationships and norms are among the most significant drivers of food environments and diets. In many countries, women decide the household's diet and, as primary caregivers, they have a strong influence on children's nutritional status. Yet they are often disempowered and neglected, and their knowledge ignored. Moreover, considering that due to social norms, care work is unequally distributed, women are negatively impacted. Therefore, women's and girl's empowerment through education, information and access to resources and services is key for FSN. Similarly the recognition, redistribution and reduction of unpaid care work would not only benefit gender equality but also FSN (ADB, 2013).

4.4.1 Cultures, rituals and social traditions

Dietary patterns not only provide nourishment but also give pleasure, and are heavily influenced by social traditions and cultures, which hinge on our ideals and sense of identity (Sobal *et al.,* 1998b; Pelto and Backstrand, 2003).

Food is "central to individual identity, in that any given human individual is constructed, biologically, psychologically and socially by the foods he/she choses to incorporate" and attempts to change diets need to take this into account (Fischler, 1988; Fischer, 2017). Fischler (1988) notes that food is about much more than macro- and micronutrients; it is intimately linked to identity and social relationships and the subjective and emotional components of food and eating should not be ignored.

The cultural perspective is useful when seeking to understand the multiple factors that affect eating, such as food production and availability, food purchases, meal preparation or meal selection, and the food environment (FAO, 2016a) because the cultures of the world bring their values, beliefs and practices to food decisions and choices. While consumption is deeply ingrained in its particular cultures and behaviour, and the demand it creates can shape supply, certain government policies, trade and corporate interests can also shape demand and consumer choices (O'Rourke and Lollo, 2015).

The types of foods people consume and the ways in which these foods are prepared, presented and consumed are repositories of tradition that embody the values of their respective cultures and sometimes in certain contexts, religion (Counihan and Van Esterik, 2013; Denning and Fanzo, 2016). Because of the strong cultural dimensions of indigenous peoples' food systems, these place-based food systems are central to the collective identity and well-being of indigenous peoples (FAO, 2009).

Most human societies have food customs and "taboos" (FAO, 1997), that are influenced by religions and beliefs, traditions, cultures and social norms and that might have positive or negative impacts on FSN. For example, many religions pronounce certain food items, and specific ways of cooking or preparing foods, appropriate and others unfit for human consumption during certain times of the year or during ceremonies (Denning and Fanzo, 2016).

Dietary restrictions and rules may govern particular phases across people's lifespan (Meyer-Rochow, 2009). Many of these rules are applied specifically to pregnant and lactating women, including rules on appropriate food intake, energy expenditure and food restrictions, which can have significant

impacts, either positive or negative, on women's lives, health and FSN. For instance, in some cultures, pregnant women are encouraged to eat less during pregnancy, supposedly to avoid difficulties during labour (Ugwa, 2016; Zerfu *et al.,* 2016; Garner *et al.,* 1992).

Social events and gatherings, holiday traditions, special occasions and religious or ritual observances that call for special foods or create food experiences also influence consumption (Monterrosa, 2017). In Timor Leste, for example, deaths and marriages are significant events that call for communities to dedicate significant resources and time, despite rural poverty. When possible, these ceremonies are usually held when people have enough resources to afford higher-quality foods, like ASF. While many in the community indicate that rituals should be less elaborate, continuance of the traditions is essential in that they reinforce social traditions that are important to FSN (Browne *et al.,* 2017).

4.4.2 Women's empowerment

The status of women around the world influences food systems and diets through their biological role in giving birth and breastfeeding, their social role as the primary caregivers for children, as well as their increasingly important role in agriculture. In most societies, women decide what the household eats. Women's status within the household influences child nutrition through their control of their time and their household income, as well as their mental health, confidence and self-esteem (Smith and Haddad, 2015; Bhagowalia *et al.*, 2012a; Smith *et al.*, 2003). At the same time, due to gender norms, women are mainly responsible for food production in many countries.

There are several other ways in which women's empowerment impacts the diets and nutrition of women and children. First, women bear an unequal burden of unpaid care work within the household. This affects the time available for other kinds of work, including paid work, and thereby has an impact on incomes and the kind of food a household can afford. Health and nutritional outcomes depend as much on childcare as on food intake. Consequently, the provision of time, attention and support to meet the needs of growing children and other family members is key to the provision of adequate nutrition (Mason and Gillespie, 1990; Longhurst and Tomkins, 1995; Haddad and Oshaug, 1999; ADB, 2013).

Second, while women constitute a large part of the agricultural workforce, their labour is often invisible. With the feminization of agriculture, women are taking on even more tasks, which can have negative impacts on nutrition outcomes (Johnston *et al.,* 2015). However access to resources is limited. In many countries, women still have limited access to and control over land. Women's responsibilities in the productive sphere and care work are often linked, and this needs to be understood. The time, poverty and physical work burden can be detrimental to their own health (Gillespie *et al.,* 2012).

Third, education for women matters. A cross-country study of developing countries covering the period 1970 to 1995 found that 43 percent of the reduction of hunger that occurred was attributable to advances in women's education (World Bank, 2013). An additional 12 percent of this reduction was attributable to increased life expectancy of women. Fully 55 percent of the gains against hunger in these countries during those 25 years were due to improvements in the situation of women within society (Smith and Haddad, 2000; ADB, 2013). Evidence has also shown that increasing the share of household income controlled by women, either through their own earnings or in the form of cash transfers, changes spending in ways that benefit the health status of children (IBRD/World Bank, 2007b). In South Asia, ensuring that women earn and control their income was one of several "success factors'' encompassed in the most effective nutrition programmes (Blumberg *et al.*, 2013).

The set of policies to promote the right to adequate food for women is far beyond measures of access to health care and food. Although these measures are fundamental, the situation of vulnerability and discrimination calls for actions to promote progress in removing all discriminatory provisions in the law (Patel, 2012; Esterik, 1999). For instance, some studies have highlighted that improving women's access to land, technical assistance and credit, as well as recognizing, reducing and redistributing the unequal share of unpaid care work through better infrastructure (i.e. access to modern stoves and electricity) and more care facilities (i.e. kindergartens and elderly care) would improve health and nutrition conditions, minimize time and the work burden, as well as social inequalities (Girard *et al.,* 2012; Allen and Sachs, 2012).

Ensuring women's rights would also have a positive effect on nutritional outcomes through overall improvements in women's empowerment as well as their spending capacity (Sraboni *et al.,* 2015). Thus, improving nutritional outcomes would require: (i) increasing household income under women's

control to improve overall household well-being (health, nutrition, literacy and happiness); (ii) ensuring women's access to markets and economic and financial resources; and (iii) increasing women's status by changing gender roles through developing agency (women's skills and self-worth), challenging power relationships and modifying laws and norms that limit women's choices. These interactions facilitate women's rights, improve economic growth and reduce poverty both for women and their households.

4.5 Demographic drivers

Population growth and changing demographics will put pressure not only on the planet, but also on the sustainability of livelihoods and development. The world's population is not only increasing, but also changing and urbanizing and people's demand and dietary needs are evolving.

4.5.1 Population growth and changing age distribution

The world's population is projected to increase from nearly 7.6 billion in 2017 to 9.8 billion people by 2050. Most of this anticipated demographic growth is expected to occur in Africa (+1.3 billion people) where the fertility rates are the highest, and in Asia (+750 million people). Europe is the only region where the population is expected to decrease from 742 million in 2017 to 716 million in 2050 (UNDESA, 2017). Just three countries – India, China and Nigeria – together are expected to account for 37 percent of the projected growth of the world's urban population between 2014 and 2050 (Crisp *et al.,* 2012).

Between 2017 and 2100, the populations of 33 countries, most of which are least developed countries (LDCs), are expected to triple. Angola, Burundi, Niger, Somalia, the United Republic of Tanzania and Zambia are projected to be at least five times more populated in 2100 than in 2017 (UNDESA, 2017). "The concentration of population growth in the poorest countries will make it harder for those governments to eradicate poverty, reduce inequality, combat hunger and malnutrition, expand and update education and health systems, improve the provision of basic services and ensure that no-one is left behind" (UNDESA, 2017).

Further declines in fertility rates and further improvements in life expectancy worldwide will result globally in an aging population. The number of people over 60 years is expected to double between 2017 and 2050 and the number of people over 80 to triple. While in 2017 the world counts more than twice as many children under 15 as people over 60, those two groups are expected to be roughly equal in 2050 (UNDESA, 2017). Africa will experience an increase in the number of young people, whereas other continents like Europe and Asia will be dealing with an aging population. This will put great tension on health and food systems (WHO/NIA, 2015). Recent evidence indicates that the elderly are susceptible to malnutrition and that their needs should be prioritized as they grow older (ICENHA, 2005; Schröder-Butterfill and Marianti, 2013).

4.5.2 Urbanization

The number of people living in cities will also increase by 75 percent between 2010 and 2050 (UNDESA, 2013; UNEP, 2016). In 1950, 30 percent of the world's population was urban and, by 2050, an estimated 66 percent will be living in urban centres. Africa and Asia currently remain predominantly rural, with 40 percent and 48 percent of their respective populations living in urban areas in 2014, but those regions are urbanizing faster than the rest of the world. By 2050, 56 percent and 64 percent of the populations of Africa and Asia, respectively, will be urban (UNDESA, 2014).

Urbanization is expected to put additional stress on food systems through increased consumption and demand for a greater diversity of foods. Urban demand will increasingly dictate what foods are grown by rural producers and how these foods are traded, processed, distributed and marketed. On the supply side, economic growth, deregulation and global trade will change the way food is produced, processed and sold, creating new markets for rural producers (Satterthwaite *et al.*, 2010). These shifts will require careful planning. Governments will need to consider their role, and the role of other actors, in anticipating how much food will be needed, what types of food, and how it should be produced if FSN is to be achieved with sustainable food systems. The "built" urban environment in which food systems operate is evolving, and can have a significant influence on nutrition (Oppert and Charreire, 2012).

While there may be many food options in cities for some, these are not equitably accessible and many people, especially those with low incomes, do not have physical or economic access to these foods. The urban poor face grave challenges related to FSN and food safety (Ruel *et al.*, 2017).

Nutritious food is not accessible in many low-income neighbourhoods, even in HICs. These food deserts or swamps offer few options for affordable, nutritious food (IPES-Food, 2017). Urban slums present additional challenges for nutrition and health. Limited access to clean water and social services as well as poor public health infrastructure leave shantytown populations at risk of both communicable and non-communicable diseases (Ghosh and Shah, 2004; Popkin, 2006b; HLPE, 2015). Nutrition outcomes in many LMICs will be affected by lack of proper planning, infrastructure and social and health services.

4.5.3 Migration and forced displacement

The food system can serve as a lens through which to view the most important problems of society. Many people around the world are moving from place to place as migrants, internally displaced people or refugees (UN, 2013; UNDESA, 2016). While some choose to move, many are forced to leave due to conflicts (see section 4.3.6) or other crises including land-grabbing or socio-economic transformation, climate change and other natural disasters (e.g. earthquakes). Food systems are often unable to respond or consistently provide healthy diets to changing fluxes of populations.

In 2015, there were 244 million international migrants, representing an increase of 40 percent since 2000 (UNDESA, 2016). These included 150 million migrant workers. About a third of international migrants are aged 15 to 34. Women account for almost half of all international migrants, many of them originating from rural areas (FAO, 2015a).

The number of people forcibly displaced, including those who are internally displaced and refugees, was 33.9 million in 1997 but increased to 65.6 million in 2016, including 40.3 million internally displaced, 22.5 million refugees and 2.8 million asylum seekers. Additionally, 10.3 million were forcibly displaced during 2016 alone. Most of these, 55 percent of refugees, were displaced by conflict in the Syrian Arab Republic, Afghanistan and South Sudan (UNHCR, 2017).

There is also considerable concern about the influence of human-induced climate change on forced displacements. McMichael (2014) indicates that climate change will adversely affect FSN in many regions, which may stimulate migration. One of the triggers will be the search for food sources that are more secure. Migration due to climate change in the coming decades may also lead to more food insecurity and malnutrition in locations where migrants resettle.

4.6 Conclusion

This chapter examined the biophysical and environmental drivers, innovation and research drivers, political and economic drivers, socio-cultural drivers and demographic drivers affecting food systems and finally impacting diets and nutrition. Analysis of these drivers shows that moving towards healthy diets and improved nutrition requires context specific changes not just in agriculture and food policy but also in political leadership, economic policy and social norms. The next chapter provides examples of policy options and pathways towards more sustainable food systems for healthier diets and improved FSN.

5 POSITIVE DIRECTIONS FOR FOOD SYSTEMS, DIETS AND NUTRITION

There has been growing recognition that nutrition and food systems need to be better considered in different sectoral policies and programmes in order to address the multiple burdens of malnutrition (Jones and Ejeta, 2016). This chapter focuses not only on nutrition-*specific*[39] policies and programmes (Bhutta *et al.*, 2013), but also aims to cover nutrition-*sensitive*[40] interventions that integrate nutrition concerns into a wider perspective and tackle broader dimensions of food systems (Ruel *et al.,* 2013; Pinstrup-Andersen, 2013).

There are many ways of acquiring evidence – from randomized control trials, to experiential evidence and traditional knowledge. While better practices to improve diets and nutritional status are emerging and continue to be collected, there is no single solution to address the multiple burdens of malnutrition: interventions and actions need to be adapted to the local context, and monitored for benefits and potential harm, as well as unexpected consequences.

Although many current policies and programmes might have unfavourable or net zero effects on nutrition and diets, this chapter focuses on successful examples to illustrate possible pathways and positive directions towards more sustainable food systems that enhance diets and nutrition. It provides an overview of some of the most promising areas where governments and other food system actors can intervene at different scales, across sectors, and across the different elements of food systems (food supply chains, food environments and consumer behaviour) with the view to improve diets and nutrition outcomes.

5.1 Priorities for action in food supply chains

Interventions across food supply chains can improve the availability, affordability and acceptability of nutritious foods. Supply chain analysis offers insights into how food systems can be improved (Ruel *et al.*, 2013; Allen *et al.*, 2016; Biénabe *et al.,* 2017 and this section will focus on how food production systems, storage and distribution, processing and packaging, retail and markets can improve diets and nutrition outcomes.

5.1.1 Production systems

Agriculture-led growth and agriculture-based solutions can make important contributions to reduce undernutrition (Webb and Block*,* 2011), as well as to dietary diversity, micronutrient sufficiency and nutritional status (Masset *et al.*, 2012). According to the World Bank, agricultural productivity is fundamental for reducing poverty, sustaining the nutritional and health status of billions of people, ensuring food security, and generating the resources to access adequate care, health, water and sanitation services (World Bank, 2007). The interactions among health, nutrition and agriculture are mutual: agriculture affects health and health affects agriculture – both positively and negatively (Hawkes and Ruel, 2006).

Improve landscape and dietary diversity

Because many poor and undernourished people are smallholder farmers (IFAD, 2016), it is often assumed that diversifying production would improve dietary diversity within the household. However, impact pathways can be long and circuitous, as shown in India by Headey *et al.* (2012). Rural areas are often particularly difficult to reach. Land parcels are small, access to appropriate technologies is limited and markets are often geographically scattered. In this context, there is no simple (nor single) answer to the question of whether it makes sense for these farmers to diversify their production and attempt to gain more of their nutrient needs from their own farms, or instead if they should invest in

[39] Nutrition-specific interventions are interventions with the primary objective of addressing nutrition and that target the immediate causes of undernutrition such as targeted supplementary feeding, vitamin A supplementation for children of 6 to 59 months of age or iron and folic acid supplementation for pregnant women.

[40] Nutrition-sensitive interventions are those in which the primary objective is not nutrition, but that have the potential to improve the food and nutrition security of beneficiaries through agriculture and food security, healthcare, education, water and sanitation, etc.

cash crops, and use the income they generate to purchase more nutritious foods (Fanzo, 2017). The appropriate answer heavily depends on the specific context and on individual choices.

Several studies have attempted to better understand the linkages between smallholder farmer production and dietary diversity in traditional food systems. Evidence gathered to date does not indicate conclusive links, but both on-farm production and the diversity of that production as well as access to markets matter for the diets of smallholder farmer families. Studies in Ethiopia, India, Indonesia, Kenya and Malawi demonstrate the importance of both homestead production and its diversity, and market transactions (Headey *et al.*, 2012; Sibhatu *et al.*, 2015; Carletto *et al.*, 2015; Koppmair *et al.*, 2016; Jones, 2017).

Solutions to increase diversity include home gardens and other homestead food production models (Olney *et al.*, 2015), intercropping and mixed landscapes (Kerr *et al.*, 2007), irrigation (Burney *et al.*, 2010), aquaculture (Murshed-E-Jahan *et al.*, 2011), and animal production systems including poultry, goats and cattle (Carletto *et al.,* 2015).

Home gardens are important sources of foods in many countries, including in the Russian Federation, where the *dacha* or private garden plot in which Russians grow their own fruits and vegetables is of critical importance. In the Moscow region, there are over one million *dachas* and some date back to the Soviet-era land distribution programmes that made it possible for Russians to survive post-war food insecurity/shortages (Burggraf *et al*., 2015). Forest landscapes and other bio-diverse landscapes as well as integrated crop–livestock farming systems can foster dietary diversity (Cuc, 2015; Remans *et al.*, 2014; HLPE, 2016, 2017). In a semi-arid area of Central Tanzania, an interdisciplinary and multi-sectoral team is working with local communities to enhance traditional integrated livestock–crop systems of nutrient-rich vegetables and small grains and the keeping of indigenous chickens raised under extensive production systems. Over a two-year period with poor wet season rains, significant reductions in stunting were noted among children under 24 months of age coming from households owning chickens when compared with those from households without chickens (Alders *et al.,* 2015; De Bruyn *et al*., 2016).

Studies also indicate that animals and fish are critically important for livelihoods, as well as for diets and nutrition (HLPE, 2016). For example, in Zambia, livestock ownership is associated with improved dietary diversity both through direct consumption of ASF and through income generated by selling these. Children living in livestock-owning households are often less likely to be stunted, regardless of household poverty levels (Carletto *et al.*, 2015). Further results indicate that expanded livestock ownership can improve livelihoods (Banerjee *et al.*, 2015) and can shift the entire local food economy in that it influences food consumption by households that lack farm animals (Jodlowski *et al.*, 2016). A project in Ecuador that provided one egg per day to children aged six to nine months found significant reductions in stunting, indicating that early introduction of eggs can improve growth in young children (Iannotti *et al.*, 2017).

In Thailand and the Lao People's Democratic Republic, crickets were previously harvested from the wild, leading to a variable supply of this nutritious food and raising food safety issues. Recently, several small- and medium-scale enterprises have developed methods of farming crickets to stabilize and increase cricket production and provide additional income for farmers (Durst and Hanboonsong, 2015).

Bio-fortification is an important way of breeding more micronutrients into specific crops (e.g. orange fleshed sweet potato in Uganda and Mozambique, rice bio-fortified with zinc in Bangladesh and India, maize bio-fortified with pro vitamin A in Nigeria and Zambia) to deliver specific micronutrients to people at risk of micronutrient deficiency particularly in Asia and sub-Saharan Africa (Tomlins *et al.*, 2007).

Safeguard Globally Important Agriculture Heritage Systems (GIAHS) in traditional and mixed food systems

GIAHS consist of important, ongoing agricultural practices and knowledge systems, and sustain high levels of biodiversity that contribute to FSN in the long term. Diversified agricultural systems are estimated to have yields between 20 and 60 percent higher than monocultures (Koohafkan and Altieri, 2010). Swiderska *et al.* (2011) found that traditional varieties grown by indigenous farmers in Bolivia (Plurinational State of), China and Kenya had higher yields and provided farmers with larger incomes. The traditional crop varieties themselves are also often better suited to harsh landscapes and climates, and GIAHS often minimize water use, improve soil and protect other natural resources, making GIAHS especially important in the face of climate change. They also support traditional cultures and rural livelihoods (Koohafkan and Altieri, 2010). The Chinese traditional rice–fish integrated farming system is described in **Box 14**.

Box 14 Globally Important Agricultural Heritage Systems in China

Rice–fish farming, an age-old practice in China, can be traced back more than 1 700 years. Fish culture in rice fields provides the simultaneous production of rice, necessary for food security, and fish, so important for providing high-quality protein, essential fatty acids and ample quantities of micronutrients. Rice yield is typically lower compared with intensive systems, but the nutrition that is harvested from the fish and other aquatic organisms provides high-quality nutrient intakes for the local population. Environmental sustainability is also enhanced, with pest management in the rice crop benefiting from fish and other aquatic organisms, and with the natural fertilization, which reinforces environmentally and economically sound farming practices.

Sources: FAO/IIRR/WorldFish Center (2001); Burlingame *et al.* (2006); Halwart and Gupta (2004).

Provide incentives to protect wild foods, local agrobiodiversity in traditional food systems

As stated earlier, studies have shed light on the positive associations between farm diversity and dietary diversity (Jones *et al.,* 2014; Remans *et al.,* 2011; Figueroa *et al.,* 2009; Masset *et al.,* 2012; Jaenicke and Virchow, 2013). Traditional food systems are often supported by indigenous knowledge systems. They rely on local and indigenous, sometimes underutilized, agrobiodiversity,[41] often complemented by the sustainable use of wild resources from forests and aquatic ecosystems (HLPE, 2014b, 2017). Agrobiodiversity is expected to influence dietary diversity in traditional food systems by giving people access to a wider variety of foods. However, that assumption does not always hold true. A study in rural areas of the Democratic Republic of the Congo showed that many of the households did not utilize the huge diversity of wild edible plants with interesting nutritional characteristics (e.g.,*Gnetum africanum* and *Treculia Africana*) freely available in the forest, the fallow lands or around the homesteads (Termote *et al.,* 2012). Similar results were found in Southern Benin (Boedecker *et al.,* 2014) and in Kenya, where in areas with higher agrobiodiverse landscapes, this diversity did not translate into differences in diet diversity for mothers, caregivers or children (Mituki *et al.*, 2017).

Among the most frequently cited reasons for the decline in use of indigenous food species are: declining availability of wild foods and forest foods due to overharvesting and land clearing for agriculture; difficulties in regaining or securing access to land and land tenure; local populations' perceptions about wild foods as being "food for the poor"; loss of traditional knowledge; high work load to collect, process and prepare traditional foods; and weak integration in market economies and globalization (FAO, 2009; Bharucha and Pretty, 2010).

[41] Agricultural biodiversity is a broad term that includes all components of biological diversity of relevance to food and agriculture, and all components of biological diversity that constitute the agricultural ecosystems, also named agro-ecosystems: the variety and variability of animals, plants and micro-organisms, at the genetic, species and ecosystem levels, which are necessary to sustain key functions of the agro-ecosystem, its structure and processes (Convention on Biological Diversity; see https://www.cbd.int/agro/whatis.shtml)

In this context, two areas of innovation should be considered to help preserve and improve agrobiodiversity for diets in these systems: first, by combining nutritional traits with environmental traits, such as tolerance to drought and salinity, as well as seasonal availability, farmers can begin to see multiple benefits of their conservation and use (Fanzo *et al.,* 2016); second, improvements in dietary diversity and quality will only be possible if agrobiodiversity is given attention by agricultural extension services (Mituki *et al.,* 2017).

Improve the links of local farms to school meals

Several countries have implemented farm-to-school programmes to improve the provisioning of nutritious foods in schools while simultaneously improving linkages between farmers and schools and creating a guaranteed market for local farmers. Although the findings related to the impact of farm-to-school programmes are preliminary, they indicate some potential trends in behaviour changes that could lead to healthier diets for children at the same time as providing more diversified income streams for local producers (Joshi *et al.*, 2008). In 2003, home-grown school feeding was included as a key intervention for improving food security in Africa's Comprehensive Africa Agriculture Development Programme (ACAADP).[42] As of 2014, 47 out of 54 African countries had implemented school feeding programmes, 20 or more of which included home-grown school feeding (Fernandes *et al.*, 2016). **Box 15** provides an overview of farm-to-school programmes in the Caribbean.

A systematic review concluded that garden-based nutrition intervention programmes (i.e. programmes that include the opportunity for youth to plant, harvest and prepare a vast array of vegetables and some fruits through a hands-on-experience that may influence intake of those foods) in certain states of the United States of America (Idaho, California, South Carolina, Kansas, Oklahoma, Minnesota and Texas) promote increased fruit and vegetable intake among youth and increased willingness to try fruits and vegetables among younger children (Robinson-O'Brien *et al.*, 2009).

Box 15 Farm-to-school programmes in the Caribbean

In St Kitts-Nevis and Trinidad and Tobago, the agriculture, education and health sectors worked together to promote a farm-to-fork initiative to tackle childhood obesity. The programme has three main pillars: (i) improving children's diets by increasing fruits, vegetables and ASF consumption; (ii) sourcing produce from local farmers; and (iii) equipping smallholder farmers so as to enhance year-round production of local fruits and vegetables. Catering staff also received training in food safety.

Yields have increased and post-harvest losses decreased since the commencement of the programme. Children in farm-to-fork schools also consumed more fruits and vegetables compared with children in schools that were not participating in the programme. Moreover, up to 90 percent of the fruits and vegetables supplied to farm-to-fork schools were sourced from local producers compared with almost no local fresh products prior to the launch of the programme.

Sources: Lowitt *et al.* (2015); Phillip *et al.* (2016).

Promote urban agriculture in mixed and modern food systems

With increasing urbanization, there is more thought being put towards urban agriculture systems and their role in feeding cities. Urban agriculture consists of ''small areas within cities, such as vacant lots, verges, shipping containers and balconies, that are used for growing crops and raising small livestock or milk cows for own consumption or sale in neighbourhood markets" (FAO, 1999).

There is a major potential with urban agriculture in growing food in greenspaces, rooftops and vertically on buildings (de Bon *et al.*, 2010). A recent analysis covering 15 LMICs found that urban populations engaged in urban agriculture ranged from 11 to 69 percent (Zezza and Tasciotti, 2010). Beyond the mere production of food, urban agriculture also contributes to the recovery of urban spaces and reconnects people with their own food, thus contributing to what is called "food citizenship" (Baker, 2004).

[42] http://www.un.org/en/africa/osaa/peace/caadp.shtml

In different cities, policies and programmes support (through provision of land, inputs or training) the development of urban gardens that enable people to produce and consume healthy food, especially vegetables. These gardens are especially important in food deserts where access to vegetables is limited. In Rosario, Argentina, 22 hectares of land were turned into gardens and 400 people were trained in gardening in 2013. In Quito, Ecuador, 2 700 gardens were created on 2 924 hectares of land and 19 200 people were trained between 2002 and 2015. In Cape Town, South Africa, 50 to 60 gardens are supported with technical and business training every year (IPES-Food, 2017).

Further investments in research and data collection are needed to better understand the current and potential contribution of urban agriculture to FSN (Orsini *et al.*, 2013) and to break current constraints to urban agriculture development, including insecure land tenure, polluted land and water, limited access to resources and support services and lack of recognition by city authorities (Zezza and Tasciotti, 2010).

Improve women producers' livelihoods

Policy interventions designed to empower women working in the agriculture sector and improve nutritional status need to be based on understanding which specific domains of women's empowerment matter for outcomes in a specific context (Malapit and Quisumbing, 2015). Although the collection of gender-disaggregated data could be more systematic, and despite regional variations, the available data (see for instance FAO, 2011b, 2014) suggest that women tend to play a lower role in commercial agriculture and in the formal forest sector, and that they are often more involved in informal activities in food production or food collection for subsistence use. Verhart *et al.* (2012) argue that these subsistence activities are often seen as an extension of their domestic responsibilities and that, in this context, women can lose the control over a production when it becomes a commercial or cash production.

Leadership in the community and control of biophysical resources related to production are the most promising areas for policy intervention to empower women and improve household food security in Bangladesh (Sraboni *et al.*, 2014). In Gambia, women control rice cultivation but when several new projects to increase rice production were implemented, they targeted men and thus were unsuccessful (Dey, 1981). These programmes should also be monitored, as it is possible that more paid work might mean women substitute convenience foods for cooking meals, particularly as these are becoming more widely available. This may explain why the relationship between women's empowerment and nutritional improvements is neither simple nor linear (van den Bold *et al.*, 2013; Bhagowalia *et al.*, 2012b; Malapit and Quisumbing, 2015; Sraboni *et al.*, 2014). Access to time-saving assets in technology and capital offset can also reduce women's work and time burdens in agriculture (Komatsu *et al.*, 2015).

Increasing women's land ownership has mixed effects. In Nepal, women who own land are more likely to have increased decision-making power and their children are less likely to be underweight (Allendorf, 2007). However, in Uganda, a study found that women's land ownership was not associated with decreased stunting in their children while women's education was (Wamani *et al.,* 2004). Further efforts are needed to better understand the role women play in food and other agricultural production along with the access they have to resources and the recognition of their double burden of paid and unpaid work in order to design effective interventions for improving nutrition.

Redirect agricultural research and development for diets

Investing in agricultural R&D may help governments to identify potential policies and programmes that could be scaled up to improve production practices (Perez and Rosegrant, 2015) and the way food moves through the supply chain, subsequently leading to improvements in diets. For example, investment in R&D in the United States of America was shown to be a major driver of productivity gains for staple crops (Fuglie and Heisey, 2007). If the implications of these increases in staple crops productivity may have had the unintended consequence of making highly-processed nutrient-poor foods cheaper, similar investments in R&D for nutrient-rich crops such as fruits and vegetables, ASF and neglected underutilized species could lead to improvements in productivity, which has the potential to lead to improvements in access to better nutrition. **Box 16** shows the importance of R&D in highlighting neglected, underutilized species as part of the local diet in the Federated States of Micronesia.

Box 16 Let's Go Local: promoting nutritious biodiversity in the Federated States of Micronesia

In the past few decades, the Federated States of Micronesia (FSM) witnessed significant shifts away from their traditional diets to an increasing dependence on imported, unhealthy foods. Nutritious local species and varieties of roots and tubers, fruits and vegetables had been replaced by highly-processed cereal products and fatty meat off-cuts – a diet high in sugar, salt and saturated fats. Obesity and diabetes as well as vitamin A deficiency diseases (VAD) were public health concerns in FSM.

To address these health and food system problems, efforts were made from 1998 onwards to identify local plant foods, such as Karat banana, an orange-fleshed banana from Pohnpei (in FSM) very rich in beta-carotene, and other yellow-fleshed bananas, that could alleviate the nutrition problems, and especially VAD. Most of this work was led by the Island Food Community of Pohnpei (IFCP), a national non-governmental organization working to promote the production, consumption and marketing of local nutritious plant diversity through its "Let's Go Local" national campaign.

A large-scale interagency, ethnographic, participatory and community-based approach was undertaken to promote local biodiversity. Two slogans were all-important: the first, "Go Yellow", focused on the yellow-fleshed varieties, including Karat, and the second, "Let's Go Local", was broader, promoting production and consumption of all local food. Many methods were used to mobilize agricultural biodiversity including: workshops; container garden demonstration plots; school visits; planting material distribution; planting, cooking and weight loss competitions; posters; youth clubs; breastfeeding clubs; billboards; mass media (newspaper, radio, television, video); leaflets, newsletters and booklets; songs; recipes; national postal stamps of Karat, other yellow-fleshed bananas and other foods; postcards, telephone cards, t-shirts, pens and pencils; gene bank; and charcoal ovens.

There is substantial evidence of the intervention's impact. Karat and many of the yellow-fleshed varieties of bananas were not sold at local markets prior to the discovery in 1998 of their rich nutrient content. Since 1999, Karat and other bananas are being sold and are available in all the local food markets and other food marts that also carry imported food.

This successful community-based approach has been developed into a set of guidelines that others can use to ensure that local biodiversity is mainstreamed in order to promote better nutritional outcomes.

Sources: Engelberger (2011); Engelberger and Johnson (2013).

Scale up climate-smart, nutrition-sensitive approaches

C*limate-smart and nutrition-sensitive* approaches that can maintain necessary levels of nutritious food production while minimizing the environmental effects of agriculture must be scaled up. Interventions in the inputs of food production, the earliest stage of the supply chain, are key (Fanzo *et al.,* 2017a). Crop and livestock diversity, soil quality and water access increase crop production and nutrition. Crop and livestock diversity also have the potential to increase dietary diversity. Such interventions include, for example, increasing irrigation to provide more reliable water for crops,[43] improving soil quality, and increasing diversity of crop varieties and livestock breeds to increase resilience to heat, drought, pests and disease.

5.1.2 Storage and distribution

The way foods are stored post-harvest and distributed can be important in ensuring consumers get access to safe and nutritious food, while minimizing waste and loss. Technologies can be important, but so can low-resource innovations.

Reduce food losses and waste

With almost one-third of food produced for human consumption – approximately 1.3 billion tonnes per year – either lost or wasted globally, the reduction of food losses and waste (FLW) is a major challenge for FSN (HLPE, 2014a). HLPE (2014a) identified inadequate storage and transport conditions and infrastructure as major causes of FLW. Strategies to improve storage and distribution infrastructure and develop and adopt novel technologies may profoundly impact food systems by

[43] Reliable irrigation is key to improve livelihood resilience of many smallholders around the world. But bad irrigation practices can also have adverse impacts on farmers and local communities, particularly for smallholder farmers and indigenous peoples, through, for instance, soil salinization or overexploitation of water resources (HLPE, 2015).

preserving perishable foods, increasing shelf life and improving food safety (FAO, 2015b). Some cities, such as Hong Kong and San Francisco, implement policies to reduce FLW and address the problem of food filling up landfills, creating GHG emissions and contaminating water (IPES-Food, 2017).

In traditional and mixed food systems, policies should focus on the development of adequate storage and transport infrastructure, including cold chains, which refers to an uninterrupted series of activities that maintain a given temperature range from the production point to the consumer (HLPE, 2014a). Cold chains are primarily used for perishable foods such as vegetables, fruits and ASF including meats, fish, dairy and eggs, which have high nutritional content. Studies in India, Ethiopia and Zambia found that refrigerated transport of fruits and vegetables as well as milk are key to reducing spoilage, increasing food safety, improving dietary diversity and creating viable export markets for producers (Maheshwar and Chanakwa, 2006; Wiersinga *et al.*, 2008; Hawkes and Ruel, 2011; Swanson, 2009).

In modern food systems, some improved technologies for storage and distribution are in development. While some of these are being piloted only in HICs because of their costs, such costs will probably come down in the future, allowing a wider use of those technologies for FLW reduction. An example is satellite technologies, including GPS, which "enables shippers and carriers to monitor quality, reduce risk (and costs) of liability claims and shorten cargo delivery time. Profitability in perishable product trade will likely increase further as technologies continue to adapt" (Coyle *et al.*, 2001).

Preserve food safety during storage and distribution in traditional and mixed food systems

Mycotoxins (including aflatoxin) can contaminate agricultural products, both in the field and during storage. Emerging research has demonstrated the utility of utilizing biological control strategies to prevent the pre-harvest aflatoxin contamination of crops (Milićević *et al.*, 2010) such as technologies that use the ability of native atoxigenic strains of the aflatoxin fungus that compete with the toxic strains. **Box 17** provides an example of improved storage techniques to reduce aflatoxin in Guinea.

Box 17 Post-harvest interventions to reduce aflatoxins in Guinea

Aflatoxin, which frequently contaminates staple foods such as maize and groundnut throughout sub-Saharan Africa, is a carcinogen and can lead to impaired growth in children. A community-based intervention to improve post-harvest practices including sorting, drying and storage by providing one-time training and materials was conducted in ten villages in the Kindia region of Guinea. Local government agricultural advisers provided guidance to subsistence farmers on a package of interventions to improve the drying and storage of groundnut. Compliance was monitored at three and five months after the intervention. Another ten villages in the region served as controls.

The concentrations of blood aflatoxin-albumin adducts from 600 people were measured immediately after harvest when the intervention took place and at three and five months post-harvest to assess the impact of the intervention. In the control villages, mean aflatoxin-albumin concentrations increased over time from 5.5 pg/mg immediately after harvest to 18.7 pg/mg five months later. In the farmers who participated in the intervention, concentrations were 7.2 pg/mg, which increased only slightly to 8.0 pg/mg at five months post-harvest. Moreover, two percent of people in the control villages had non-detectable adduct concentrations as compared with 20 percent in the intervention group.

Source: Turner *et al.* (2005).

5.1.3 Processing and packaging

Interventions aimed at improving food processing and packaging can enhance the nutrient content of foods. In traditional food systems, staple grains are often milled into flours at local levels. Fruits can be dried and packaged and transported to local markets. In mixed and modern food systems, foods can be more heavily processed into canned, frozen or processed packaged foods for consumption. Overall, most people in the world are net-buyers of foods that have been altered from the farm at some level.

Develop and promote policies, practices and technologies that protect or add nutritional value along food chains

Policies and programmes can be put in place to preserve or add micronutrients into foods during processing (i.e. fortification) or to remove less healthy ingredients (e.g. product reformulation to reduce sodium and trans fats). Examples of processing include milling, dehulling, germinating and fermenting to remove anti-nutrients such as phytates, polyphenols and trypsin inhibitors that impact the absorption of key nutrients (De Pee and Bloem, 2009). More evidence and more solutions related to primary processing are needed (Hotz and Gibson, 2007; FAO, 2015c). The impacts of processing technologies on nutrient content and bio-availability (such as germination, malting and parboiling) still need to be better understood and accounted for by all actors.

Processing and packaging methods such as canning, freezing and Tetra Pak technology can extend shelf life and ensure that perishable foods can reach those vulnerable groups who cannot access or afford fresh products.

Facilitate, as appropriate, the use of food fortification in traditional and mixed food systems

As shown in Chapter 2, food fortification can improve micronutrient intakes and, in some cases, health outcomes (Das *et al.*, 2013) because it "has the dual advantage of being able to deliver nutrients to large segments of the population without requiring radical changes in food consumption patterns" (WHO, 2015e).

For example, salt iodization programmes have reduced the risk of goitre, cretinism, low cognitive function and iodine deficiency in countries worldwide (WHO, 2014b). An innovative partnership in Ethiopia on salt iodization is shown in **Box 18.** Iron fortification has been very successful in improving haemoglobin and iron status of women and children (Das *et al.*, 2013; Gera *et al.*, 2012) through a variety of fortified foods including rice in the Philippines, soy sauce in China (Chen *et al.,* 2005), fish sauce in Viet Nam (Thuy *et al.,* 2003) and cornflour in Venezuela (Bolivarian Republic of) (Mannar and Gallego, 2002). Fish powder is promoted in Cambodia in an effort to improve nutrient intakes during the first 1 000 days of a child's life (Bogard *et al.*, 2015).

Box 18 A partnership among government, non-governmental organizations and producer cooperatives to improve iodized salt coverage in Ethiopia

In 2005, the Ethiopian Health and Nutrition Research Institute (now called the Ethiopian Public Health Institute) estimated that over 83 percent of school children had mild to severe iodine deficiency, as measured by urinary iodine concentration. Goitre rates of 40 percent in children and 36 percent in mothers were also found, which are also indicative of severe iodine deficiency. Moreover, surveys indicated household coverage of iodized salt in Ethiopia to be as low as 4.7 percent in 2008. To address this gap in coverage, the Global Alliance for Improved Nutrition (GAIN) has been supporting the National Universal Salt Iodization (USI) Program in Ethiopia since 2009 through technical and financial assistance working with government, the salt industry, civil society and consumers to increase the availability and access to adequately iodized salt as part of improving the national food system. GAIN has provided input and built capacity across the entire fortification impact model, from foundation building, set-up and launch stages through to scale-up and delivery and demonstrating impact. One critical activity of GAIN's support has been the successful establishment of a viable national revolving fund with distribution for potassium iodate. Preliminary results from the 2014 National Micronutrient Survey indicated that coverage of iodized salt has increased significantly during the time of GAIN's engagement: 95.2 percent of households now have access to salt with some iodine and 42.7 percent of households have access to salt that is adequately iodized to national standards. Preliminary data from a cluster randomized control trial examining the impact of fortification in children under 36 months in 60 villages in Amhara have suggested improvements in children's iodine status, mental development and growth.

Source: Garrett *et al.* (2016).

Regulate food processing in mixed and modern food systems

In some countries, food processing policies and programmes have targeted trans fats and sodium to reduce the burden of NCDs (WHO/WEF, 2011).

Partially hydrogenated oils (PHOs) are the main dietary source of trans fats. They entered the food supply in the early 1900s and quickly became a key ingredient in processed foods given their low cost and long shelf life. Denmark was the first country to ban industrially produced trans fats in 2003, paving the way for other countries, states and cities to implement similar policies. The ban in Denmark virtually eliminated trans fats from the food supply. In the United States of America, a more local approach to trans fat bans has been adopted. New York City was the first city in the United States of America to ban trans fats in restaurants and fast-food outlets, which led other jurisdictions to adopt similar policy measures, reducing the quantity of trans fats in the food supply. More recently, the Food and Drug Administration (FDA) of the United States of America proposed to remove the "generally recognized as safe" (GRAS) status from PHOs in that country, which would essentially act as a countrywide trans fat ban.

Mandatory labelling of trans fats has been another approach to reducing trans fat availability in the food supply. Canada and the United States of America were the first countries to adopt trans fat labelling, which led the food industry to reformulate many of their products leading to significant reductions in trans fats in the food supply (Mozaffarian *et al.,* 2010; Ratnayake *et al.*, 2009), which coincided with reductions in trans fat levels in blood serum (United States of America) and breast milk (Canada) (Ratnayake *et al.*, 2014; Downs *et al.*, 2013).

Prepared and processed foods can contain high amounts of "hidden" salt given that consumers are not aware of and may be desensitized to those amounts (He *et al.*, 2012). Setting recommended or mandatory targets or standards for salt levels in different categories of foods might be one of the most effective ways to reduce this "hidden" salt consumption. As of 2015, 75 countries had developed national salt reduction policies (Trieu *et al.*, 2015). There is some evidence to indicate that sodium consumption has declined due to improvements in knowledge, attitudes and behaviour in some countries; however, more rigorous evaluations of salt reduction programmes are needed (Trieu *et al.*, 2015).

In the United Kingdom, a salt reduction programme was established in 2003 and continued until 2010, consisting of three key elements: (i) setting targets and working with industry to reformulate foods to reduce salt levels; (ii) encouraging the use of improved nutrition labelling to make it easier for consumers to make healthier choices; and (iii) undertaking campaigns and working with non-governmental organizations (NGOs) to raise consumer awareness about salt consumption. Throughout the seven years of the salt reduction programme, there were substantial reductions in the salt content of foods (up to 70 percent) as well as a 15 percent reduction in sodium levels in humans, as measured through 24-hour urinary sodium excretion (He *et al.*, 2014; Wyness *et al.*, 2012).

5.1.4 Retail and markets

Once food is produced and moved through the food supply chain, it hits the retail space through various types of markets. Markets are highly variable in what they provide but also in how they are accessed and by whom.

Improve connectivity of smallholders to markets in traditional and mixed food systems

While some smallholders only grow food for their own consumption, most of them also sell some of the food they produce and need access not only to local markets but also to national ones. Globally, 80 percent of smallholders operate in local and domestic food markets (CFS, 2016). There are many barriers that prevent smallholders from accessing and benefiting from markets and that need to be addressed through policies and investment (HLPE, 2013). A lack of storage, including cold storage, means smallholders often need to sell their products soon after harvest when prices are low. Lack of transportation and road infrastructure makes it difficult for smallholders to reach markets and leads consumers, especially in cities, to rely more heavily on imported food. As shown by Tacoli (2003), this disconnect between rural smallholders and urban markets exacerbates rural poverty. In some cases, new markets need to be created and adapted standards need to be implemented. Smallholders also need bargaining power at markets that can be accomplished through farmer cooperatives or other organizations and governments and NGOs can support these. The HLPE also recommended that governments should prioritize smallholders when sourcing food for school and institutional feeding programmes (HLPE, 2013). In 2016, CFS made a list of recommendations on connecting

smallholders to markets. These include making the product demand more consistent and reliable, increasing smallholder access to market price information as well as taking actions to stabilize these prices, increasing smallholder participation in decision-making and supporting smallholder organizations, and improving processing and storage as well as roads (CFS, 2016).

Encourage supermarkets to procure "healthier" foods in mixed and modern food systems

The "supermarket revolution" in developing countries is impacting dietary patterns and nutritional outcomes. Policies and programmes should be developed to encourage supermarkets to supply more nutritious food items such as fresh fruits and vegetables at affordable prices, and to procure local products, particularly from or smallholders, as has been done in China. In this country, several policy changes increased the number of supermarkets, such as liberalization of retail and government investment in supermarket chains. In Shanghai, the top three chains are managed by the municipal government and are provided with easy access to capital. A government programme, *nonggaichao*, explicitly converted wetmarkets to supermarkets through an auction system from 2003 to 2007 in several large cities throughout the country. Supermarkets have then aimed to increase sales of fresh products by optimizing procurement to reduce prices to be more competitive with wetmarkets (Reardon and Gulati, 2008; Hu *et al.*, 2004).

In South Africa, private health insurance company partnerships with supermarkets led to improvements in nutritious food purchases and lower consumption of foods high in salt and/or sugar, fried foods, processed meats and fast food (Sturm *et al.*, 2013; An *et al.*, 2013). In East Africa, African leafy vegetables (such as kale, nightshades, cowpea greens and pumpkin greens) have become a niche crop, and women farmers are supplying them to larger supermarket chains (Cernansky, 2015). Nutritious crops such as quinoa, millet and teff, meanwhile, are progressively becoming more common in Western supermarkets, with potential benefits for smallholder farmers (Bellmare *et al.*, 2016). The dynamics of the supermarket could change rapidly over the next decade with online shopping. Some of the downsides of these changes and technologies are that they could reduce employment opportunities, discourage cooking, increase the consumption of packaged foods that are not necessarily healthy, and generate more waste.

Support farmer connectivity through information technology

Linked to markets, information technology has played an increasingly important role in today's business activities associated with delivering nutritious foods to markets, which has led to the emergence of e-commerce. In developing countries, business-to-consumer (B2C) e-commerce is rapidly expanding, particularly in Asia and Africa. China has already emerged as the largest global market for B2C e-commerce (UNCTAD, 2015). The development of e-commerce has been affecting the food system, and the relationship has changed across the actors in the food supply chain. Agricultural firms have been changing the way they think about their business structure and functions by adopting e-commerce practices (Manouselis *et al.*, 2009). The development of e-commerce provides new opportunities for farmers, including smallholders, to develop their own businesses and implement their innovative ideas. They could also be involved in the food supply chain and build closer market linkages with customers who are demanding certain types of foods through e-commerce platforms. Due to the existence of several barriers to further development, governments need to take actions to establish a good e-commerce environment for related actors, including making national strategies for medium- or long-term development, building legal and regulatory frameworks for trust transactions between traders, improving awareness and knowledge related to e-commerce among different actors and providing ICT infrastructure.

5.1.5 Evidence gaps in the food supply chain

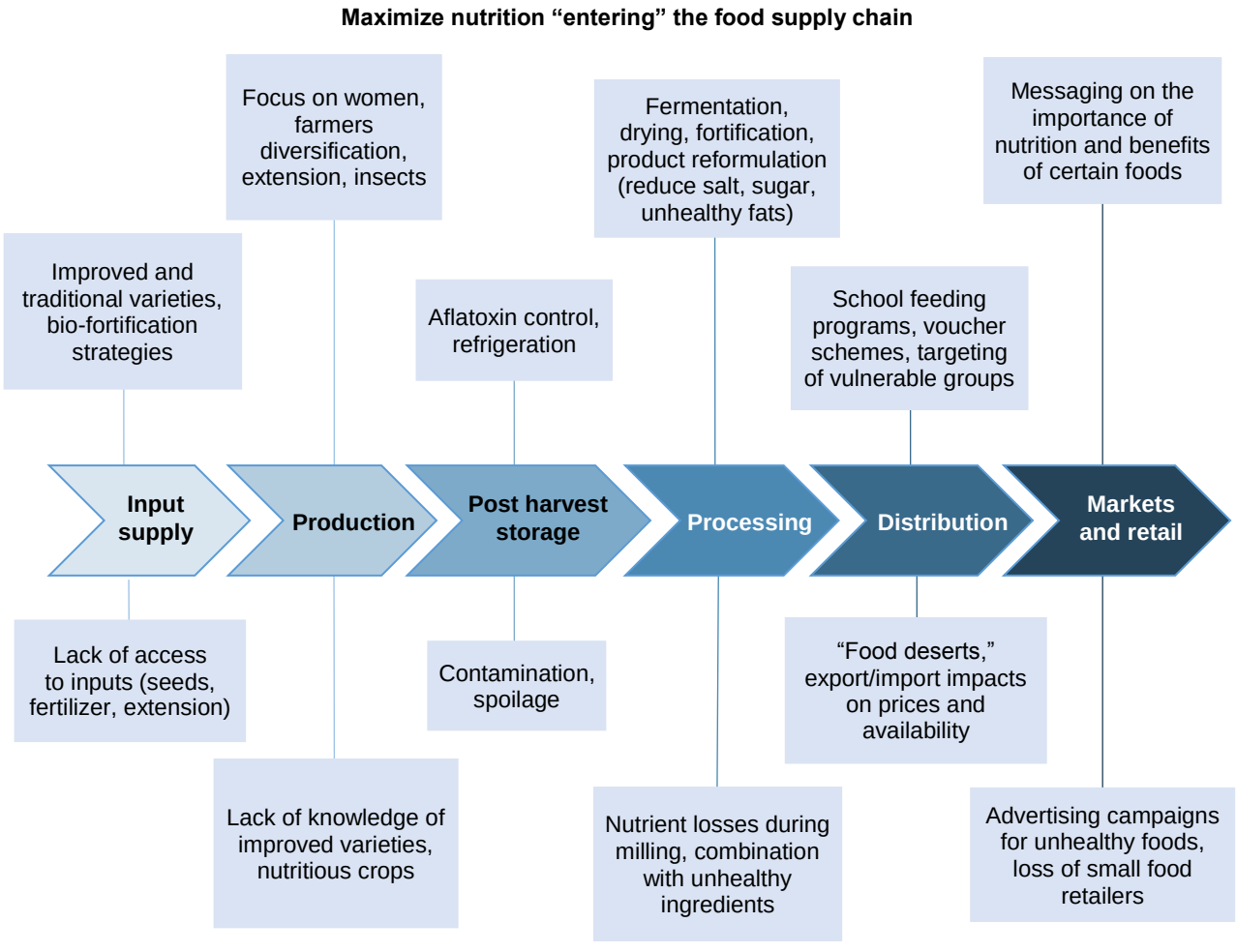
There is still a gap in the evidence regarding what are the best production systems for improving nutrition, while also ensuring sustainability and economic viability in low- and middle-income settings. First, more studies are needed that have rigorous designs, methods and metrics to assess the impacts of household food production strategies on biological and dietary indicators of nutrition (Girard *et al.,* 2012). Second, smallholder farms do not exist in isolation. The relationship between production and consumption diversity needs to be considered at spatial scales beyond households, including subnational scales capturing the landscape level (Remans *et al.*, 2015). Third, there are significant trade-offs for farmers in their farming decisions. Many farmers are seeing themselves obliged to diversify their employment portfolio. This makes research into production-to-diet pathways more complex, yet all the more important to focus on (Fanzo, 2017). Fourth, research on biodiversity will continue to be important in the future, especially in terms of neglected and underutilized species

and orphan crops. Greater understanding of the nutritional and toxicological properties of underutilized species is needed (Bharucha and Pretty, 2010), and there is a need for whole value chain research to promote the production, marketing and consumption of orphan crops (Gómez *et al.,* 2013). Last, in all food systems, many small- and medium-sized enterprises (SMEs) provide a critical link between smallholder producers, markets and consumers in both rural and urban areas. However, SMEs still face many challenges that limit their contribution to FSN, including a limited access to technologies, credit and infrastructure, limited capacities to influence and implement standards, as well as a lack of knowledge of the determinants of consumer behaviour.

5.1.6 Key points of interventions across food supply chains

Food supply chains can be improved to ensure nutrition enters the chain by increasing access to nutrient-rich foods while, at the same time, maintaining or increasing the nutritional value of products as they move along the supply chain. This may occur in various ways – by the creation of crop-diverse production landscapes for instance, the utilization and promotion of local, underutilized species in sustainable ways, or the cultivation of bio-fortified crops such as orange-fleshed sweet potato (Tomlins *et al.,* 2007; HarvestPlus, 2014), among other means. Food supply chains can also reduce levels of nutrients associated with diet-related NCDs (e.g. trans fat, sodium and sugar).Food supply chains can thus either maintain or increase nutritional value or cause nutrition to exit the chain when nutrients are removed from a given food as it moves along the chain. **Figure 14** depicts the ways in which nutrition can enter and exit the supply chain. As shown in the previous sections, interventions are possible at each stage of the food supply chain.

Figure 14 Exit and entry points along the nutrition value chain



Source: Fanzo *et al.* (2017b).

5.2 Priorities for action in food environments

Healthy food environments facilitate healthier food choices. Although there has been substantial research describing food environments in HICs, less attention has been given to LMICs. Nevertheless, policies and programmes aimed at improving the quality of the food environment have been implemented worldwide, some of which are described in the section below.

5.2.1 Availability and physical access (proximity)

The physical access to diverse types of food in a given food environment influences what consumers can purchase and subsequently consume. Policies are needed that encourage healthy outlets and combat the spread of food deserts. These may be different than the policies required to rectify "food swamps" (e.g. zoning powers to restrict "unhealthy" food retail outlets (such as fast-food restaurants) near schools). Food deserts and swamps are an increasing problem in LMICs, particularly in mixed food systems, as these countries urbanize.

Address food deserts and food swamps in mixed and modern food systems

Mobile markets and food carts can improve access to healthy foods, such as fruits, vegetables and ASF in food deserts and swamps. Studies in the United States of America, Philippines, Thailand, Indonesia, Bangladesh, Egypt, Nigeria and Senegal have shown that these had nutritional benefits in each of these countries (Tinker, 1997). Food carts have also been shown to be a good solution in Kumba and other cities in Cameroon (Acho-Chi, 2002; Zepeda and Reznickova, 2013).

Several cities in the United States of America have begun initiating policies to improve the availability of healthier foods in low-income neighbourhoods, including in Philadelphia, Baltimore and New York City, among others. **Box 19** provides an overview of the policies that have been put in place in New York to address the issue of food availability.

Bridle-Fitzpatrick (2015) found that, in Mexico, food swamps are a bigger problem than food deserts. One potential solution is for fast-food and other food retailers to offer more nutritious options. Fast-food outlets are now offering healthier options, including fruits, salads and rotisserie chickens and not just fried foods. This trend needs to be reinforced by public policies in order to enhance the accessibility and affordability of these foos.

Box 19 Increasing the availability of fruits and vegetables in low-income neighbourhoods of New York

In an effort to increase fruit and vegetable consumption among lower socio-economic groups in New York City, the city has implemented several initiatives aimed at improving both the supply of and the demand for fruits and vegetables. These include Green Carts, the Healthy Bodega Initiative and the Food Retail Expansion to Support Health (FRESH) programme.[44]

New York City provided vendor licences for Green Carts that sell fresh fruits and vegetables in low-income neighbourhoods. An evaluation of this programme found that the Green Cart programme was reaching low-income populations, some of which reported increasing their fruit and vegetable consumption since shopping at the Green Cart.

There is some evidence to indicate that the Healthy Bodega Initiative,[45] which works with *bodegas* to increase the sale of low fat milk, vegetables and fruit, and with community organizations to increase consumer demand for these foods, led to increased sales of healthier items and some improvements in consumer purchases (Dannefer *et al.*, 2012).

Finally, the FRESH programme provides zoning and financial incentives to promote the establishment and retention of grocery stores in underserved neighbourhoods. Nineteen FRESH projects have been approved and nine stores have opened since the programme was launched in 2008. A survey of shoppers conducted by the New York Economic Development Corporation (2015) found that 80.4 percent reported purchasing more fruits and vegetables since the stores opened.

Sources: Dannefer *et al.* (2012); Downs and Fanzo (2016); NYCEDC (2015).

[44] See: https://www.nycedc.com/program/food-retail-expansion-support-health-fresh

[45] See: http://www1.nyc.gov/assets/doh/downloads/pdf/cdp/healthy-bodegas-rpt2010.pdf

Encourage healthier diets through public procurement of foods

The provision of food in schools, hospitals, workplaces and government buildings has the potential to improve diets and to influence production, including through sourcing food from local producers, e.g. in Brazil (Hawkes *et al.* 2016). In Japan, the "Table for Two" programme tackles obesity and malnutrition at the same time by "transferring" excess energy to those who need it. This is achieved by partnering with corporations to provide healthy, lean meals in cafeterias, restaurants, vending machines and now food trucks at an extra USD 0.25 or 20 yen, which is donated to local organizations in Africa that provide meals to children (Table for Two, 2017).

School meals provide the opportunity to ensure that children in school get at least one healthy meal per day. They also provide opportunities for supporting local farmers. Home-grown school feeding programmes exist throughout sub-Saharan Africa. In the case of the Ghana School Feeding Programme, the creation of local markets also increased food security as measured by household food access and months of the year with food security for people living around the schools (Sumberg and Sabates-Wheeler, 2011). A randomized trial in Burkina Faso compared school lunches to take home rations for girls enrolled in school and found that both attendance and mathematics scores improved but also that the take home rations improved sibling nutritional status (Kazianga *et al.*, 2009). A study in the United States of America found that school meals can have positive impacts on the dietary quality of those children who are nutritionally disadvantaged more so than on those children who are less in need (Smith, 2017).

5.2.2 Economic access (affordability)

For consumers to be able to purchase and consume the foods that are available within the food environment, these also need to be affordable.

Promote healthier diets through discriminatory trade policies

Trade policies impact the food that is available and affordable within a given country. They can shift production patterns and lead to improvements in the way food is produced and traded. Open trade is generally associated with lower food prices (see section 4.3.2 above). However, open trade can make it more difficult to limit access to unhealthy food. **Box 20** provides an example of how open trade was curtailed to reduce the availability of fatty meats in Pacific Island countries.

Box 20 The use of trade-related policy to reduce fatty meat availability in Samoa and Fiji

Trade-related policy has been used as a tool to try to address the "dumping" of fatty meats in the Pacific Island countries of Fiji and Samoa. In Fiji, the sale of mutton flaps was banned in February 2000. In August 2007, the Government of Samoa banned turkey tail imports given concerns related to their high fat content (32 percent). Both these policies led to a sharp decline in the availability of these fatty meats.

In Fiji, prior to the ban, 221 tonnes of mutton flaps were exported from New Zealand and by 2001 no flaps were exported from New Zealand. Then, imports increased again to reach around 115 tonnes in 2005, likely because the ban focused on sales rather than imports. Thus mutton flaps could still be imported for processing if not for direct sale.

In Samoa, turkey tail imports ceased after the ban. A survey conducted by the Samoan Nutrition Centre found that just under half of respondents shifted consumption from turkey tails to other cheap meats including sausage or mutton; however, approximately a quarter reported eating lower-fat meat or seafood, and a few respondents reported eating less meat overall due to the ban. Nevertheless, as part of Samoa's accession to the World Trade Organization in 2011, the ban on turkey tails was removed, given that it was considered a barrier to trade. It has now been replaced by a 300 percent import duty.

Sources: Thow *et al.* (2010b, 2014a).

Encourage healthier diets through taxes and subsidies

Making nutritious foods cheaper and unhealthy foods more expensive, for instance through taxes and subsidies, may be one way to influence consumers' behaviour and subsequent food intakes (Eyles *et al.*, 2012; Thow *et al.*, 2014b; Thow and Downs, 2014). There is strong evidence to suggest that taxes and subsidies are an effective tool for changing dietary intakes. Some studies (Thow and Downs, 2014; Thow *et al.*, 2014b) showed that the consumption of taxed sugar-sweetened beverages (SSBs) can be reduced in the range of 20 to 50 percent while the consumption of subsidized fruits and vegetables can be increased in the range of 10 to 30 percent. **Box 21** presents the taxation of SSBs and foods of high caloric density implemented in Mexico.

Box 21 Taxation of sugar-sweetened beverages and non-essential energy-dense foods in Mexico

In January 2014, an excise duty of one peso (i.e. around 10 percent) per litre was applied to sugar-sweetened beverages (SSBs) and an *ad valorem* excise duty of 8 percent was applied to non-essential energy-dense foods.

A recent survey carried out on consumer purchases from January 2012 to December 2014 was used to examine purchases of over 6 000 households. The volume of food purchases that was taxed and untaxed in these households was examined from January 2012 to 2014, controlling for household characteristics and contextual factors.

In December 2014, purchases of taxed SSBs had declined by 12 percent, and by 17 percent among lower socio-economic households, compared with pre-tax trends. Moreover, purchases of untaxed beverages were 4 percent higher than the counterfactual, mainly attributed to increased bottled water purchases.

A similar pattern was found for non-essential energy-dense foods, where there was a 5.1 percent reduction in purchases beyond what would have been expected based on pre-tax trends. There were no corresponding changes in purchases of untaxed foods. Among low socio-economic households, there was a 10.2 percent reduction in the purchases of taxed foods compared with what would have been expected – high socio-economic households did not change their purchasing habits.

Sources: Batis *et al.* (2016); Colchero *et al.* (2016).

There are also several studies with mixed results related to the Public Distribution System (PDS) in India. One study found that access to subsidized grain through the PDS has had a positive impact on calorie consumption as well as on selected nutrients (Parappurathu *et al.,* 2015). On the other hand, Kaushal and Muchomba (2015) found that, while the increase in income resulting from the subsidy led to a reduction in the consumption of coarse grains and increased expenditure on non-food items, it had no effect on nutrition in poor households.

One argument against food taxes is their potential regressivity: they impose a larger burden on the poor than on the rich. Thow *et al.* (2010a) found that combining food subsidies with taxes could help alleviate this potential regressivity and enable consumers to switch to more healthy products without incurring additional costs. The review indicates that food subsidies and taxes can influence consumption in HICs and that imposing substantial taxes on fattening foods may improve health outcomes such as overweight, obesity and chronic diseases. Further research is needed on consumer responses to food taxes in developing countries (Thow *et al.,* 2010a). A summary of the evidence on taxes and subsidies is presented in **Table 5**.

Table 5 Summary of evidence on taxes and subsidies

	Food / beverage taxes	Nutrient-focused taxes	Subsidies
Effect on consumption	Strongest evidence for SSB taxes – reduce consumption by same percentage as tax rate.	Reduce consumption of target but may increase consumption of non-target nutrients; may apply to core foods; better if paired with subsidy.	Increase healthy food intake. Strongest evidence for fruit and vegetable subsidies.
Effects on body weight/disease outcomes	Substitution will affect total calorie intake. Most effective to target sugar sweetened beverages. Limited evidence for disease outcomes.	Disease outcome affected by substitution – nutrient profile taxes less likely to have unintended effects than single nutrient-based taxes.	May also increase total calorie intake and body weight. Very likely to reduce dietary NCD risk factors.
Differential effects	May be most effective for low-income populations; may have greater effect on those who consume most.	May be more likely to have regressive effects as more likely to apply to core foods.	Mixed socioeconomic status effects for population subsidies, may benefit wealthy. Targeted low-income subsidies effective.

Source: Thow *et al.* (2014b).

Promote healthier diets through price promotions in mixed and modern food systems

Price promotions are an effective tool to encourage consumers to purchase nutritious and healthier foods. Price decreases have been associated with increased purchases of some nutrient-dense foods (Chandon and Wansink, 2012).

Understand the effect of remittances on nutrition status in traditional food systems

Remittances can increase access to (purchased) food and may have a consumption smoothing effect, reducing households' vulnerability and leading to improved food security and reductions in underweight. However, remittances appear to have little effect on markers of chronic undernourishment. Evidence also indicates that the extra income from remittances may compound trends towards purchasing less healthy foods that are associated with the nutrition transition. There is an urgent need for further research on the effect of remittances on nutrition and diets, with remittance income forecast to rise rapidly into the future due to globalization and migration (Thow *et al.*, 2016). Programmes to ensure that those households receiving remittances move beyond just meeting energy sufficiency needs to improve their dietary quality could create nutritional benefits (Thow *et al.*, 2016).

5.2.3 Promotion, advertising and information

Promotions, marketing and advertising influence consumer decisions on what types of foods to purchase and consume. Promotions can be done through foods on sale at a reduced price (e.g. two for one), premiums, sampling, coupons, contests, sweepstakes and event marketing. There are many techniques to market and advertise foods to influence food purchase behaviour, including television advertising, packaging, in-school marketing, product placements, the Internet, toys and products with brand logos, and youth-targeted promotions, such as cross-selling and tie-ins (Story and French, 2004).

Promote healthier food options

Promotion of foods, such as placement in markets or on store shelves, and branding, influence food preferences in ways that consumers may not be consciously aware of (Chandon and Wansink, 2012). Placement strategies may involve positioning products at eye-level or using product grouping to influence purchasing, though further studies are needed to evaluate such strategies. The physical location of products in a store can also create comparisons between attributes, such as when the placement of a low-fat, nutrient-poor food in the health food aisle leads the consumer to perceive the product as being better tasting and more healthy than when the product is displayed in a section where there are other nutrient-poor foods (Glanz *et al.*, 2012). Children are especially influenced by package design, colour and character branding, using these cues to determine whether a product is "fun" or "healthy and boring" (Glanz *et al.*, 2012). However, this can also be utilized to improve children's diets by using familiar cartoon and media characters to increase fruit or vegetable consumption among children (Kraak and Story, 2015).

Strengthen regulations for advertising and marketing

Advertising and marketing influence consumer preferences and increase consumer demand for certain food products. Marketing to children is especially problematic. Children require special protection, and are particularly susceptible to influences such as food marketing and advertising.

Although there have been steps taken to reduce marketing to children over the past decade, most notably with the WHO recommendations on marketing of foods and non-alcoholic beverages to children, endorsed by the World Health Assembly in 2010 (WHO, 2010d), insufficient progress has been made (Kraak *et al.*, 2016). Stronger regulatory approaches are needed, particularly advertising bans to children. Barennes *et al.* (2016) suggest measures such as: large-scale education campaigns; exclusion of the infant formula industry from nutrition education and policy roles; and strong penalties for violations of the International Code of Marketing of Breast-milk Substitutes.

Countries committed to scaling up nutrition should begin by regulating the marketing of commercial infant formula and other breast-milk substitutes and by implementing the full set of WHO recommendations on the marketing of breast-milk substitutes and of foods and non-alcoholic beverages to children (De Schutter, 2011). The International Code of Marketing of Breast-milk Substitutes needs to be strictly enforced through accountability mechanisms and international legislative enforcement.

The obesity crisis cannot be solved without dramatic changes to the obesogenic marketing environment that surrounds children (Harris *et al.*, 2009). Public officials have a responsibility to intervene through policies such as banning the promotion of unhealthy food advertisements or other methods targeted at children, subsidizing healthier alternatives and restricting or banning certain ingredients (Harris and Graff, 2015). Governments also are justified in intervening in schools to promote healthier approaches to eating and physical activity. With regard to advertising junk food to children, various types of legislation should be considered by states to put strict measures in place to protect children and assist parents in promoting healthy eating at the household level. Education of parents and childcare providers on good childhood feeding practices can also impact food-purchasing behaviour.

Increase transparency of information on labels

Nutrition labelling has been commonplace in many countries for several decades. It aims to provide consumers with information about the nutrient content of a given food. The Codex Alimentarius Commission, established by FAO and WHO has developed standards for nutrition guidelines on food products (FAO, 2012b). Although many countries have adopted back-of-the-pack (BOP) and front-of-the pack (FOP) information on energy and specific nutrients since the development of the CODEX guidelines, there is limited evidence to indicate that these labels have influenced consumer comprehension and food-purchasing decisions (Mandle *et al.*, 2015; UNICEF, 2016d).

Mandle *et al.* (2015) noted that labelling research and reviews focus mainly on Western countries with limited peer-reviewed analysis on labelling in countries in the global South calling for more research evidence in these regions. In Latin America, despite the prevalence of FOP labelling components, there is a lack of studies evaluating impact or effect on diets and nutrition in the region (UNICEF, 2016d).

These labels require some degree of nutritional literacy, and are difficult to interpret for many people. For this reason, there have been recent moves to adopt easy-to-interpret labels (e.g. traffic light, star ratings, etc.) on FOP or on store shelves. It is thought that labels of this type are easier for consumers to interpret and may help them make better food choices. However, the evidence related to purchasing behaviour and intake associated with labels is both limited and mixed (Hersey *et al.*, 2013). Studies indicate that consumers can more easily interpret and select healthier products with nutrient-specific FOP nutrition labels that incorporate text and symbolic colour to indicate nutrient levels rather than nutrient-specific labels that only emphasize numeric information, such as guideline daily amounts expressed as percentages and/or grams. Summary systems may influence consumers to purchase healthier products (Hersey *et al.*, 2013).

FOP labels can provide an incentive to industry to reformulate their products. There is preliminary evidence to indicate that Ecuador's front-of-pack traffic light labels have led to product reformulation by large and medium food industries with over 20 percent of them reporting a reformulation of at least one product that contains the red traffic light for sugar, fat or salt (ANDES, 2016). France, in its law of modernization of the health system (Law n°2016-41, article 14-II), plans to establish a voluntary graphic nutritional label in order to illustrate the mandatory nutritional information required by the European regulations and to facilitate consumer choices (WHO, 2017c). An innovative front of the pack labelling system has also been implemented in Chile as shown in **Box 22**.

Box 22 Regulation of marketing, labelling and the school environment in Chile: a comprehensive policy to tackle obesity and improve the food system

By 2014, Chile had the second highest obesity prevalence in Latin America, after Mexico. Approximately two-thirds of Chilean adults were overweight, and 27.8 percent were obese (PAHO, 2016a). Such figures have been fuelled by the increasing consumption of highly-processed products in the country: sales had grown from 125.5 kg/capita/year in 2000 to 200.6 kg/capita/year in 2013, ranking Chile as the country with the second highest per capita sales of highly-processed products in Latin America (PAHO, 2015).

The Chilean Government led a thorough process of debate and investigations in the country that resulted in the publication of Law 20.606 in 2012 (Chile, 2012), which stipulates that food and drink products shall be labelled with front-of-pack nutritional warnings if high in energy, fats, sugars and/or salt. These front-of-pack labels[46] came into effect in June 2016. They consist of a black stop sign for items with high quantities of energy, saturated fat, sugar and sodium.

This law has contributed to build a healthier food system by:

- warning citizens about products that should not be the basis of people's diet (application of abovementioned front-of-pack warning system);
- restricting the demand for such products (ban on the advertising of such products to children); and
- protecting the school food environment (prohibition on the sale, provision, promotion or marketing of such products in schools).

The regulation restricts advertising of products that require a stop sign to children under the age of 14. If foods have the black stop sign, they are also not allowed to be advertised on TV or distributed in schools. This takes labelling one step further in that it promotes programmatic action.

Since the law's introduction, 93 percent of the population of the Metropolitan region of Santiago de Chile recognizes the front-of-pack nutritional warnings, and 92 percent has declared that the warnings have been influencing their purchasing decisions, of which 68 percent indicate that when deciding between products, they choose those with fewer or no warnings (Valdebenito *et al.,* 2017).

5.2.4 Food quality and safety

Consumers are increasingly concerned about food quality and safety (Euromonitor International Passport, 2015; Alexander-Kasriel, 2016), while at the same time there is growing interest in "functional" foods[47] that may be health-promoting, although the effects of this trend are controversial and require further research.

Certify food safety across all food systems

There are many technologies, including removal and inactivation that reduce microbial activities, or emerging and innovative technologies, such as filtration, centrifugation and separation (Koutchma and Keener, 2015) relevant to food safety at all levels of the food supply chain. However, because most food-borne illnesses occur in developing countries, emphasis is placed on making existing technologies more affordable and accessible. For instance, drinking water disinfection is a vital part of protecting the public from outbreaks of infectious and parasitic diseases found in water (Amy *et al.*, 2000). Adding chlorine, chloramines, ozone, iodine, chlorine dioxide and ultraviolet light are common ways to improve water's microbial, chemical and aesthetic qualities (AwwaRF, 2007).

Many cities implement policies and programmes to improve food safety in urban environments. In Abidjan, Côte d'Ivoire, and Oakland, United States of America, street food vendors were licensed in order to increase hygiene standards and decrease food-borne diseases (IPES-Food 2017). In Dhaka, Bangladesh, a safe food cart initiative aimed to decrease bacterial contamination of street food by providing training and selling street carts to those who complete the training. The street food vendors have to charge higher prices to cover the cost of the cart but vendors report customers being willing to pay for safer food. Viet Nam and Thailand have also enacted laws and programmes to improve food safety in urban street food (Germain, 2017). In Shanghai, China, all food businesses are required to be part of the Shanghai Food Safety Information Tracing Management Regulation Program to

[46] See: http://web.minsal.cl/wp-content/uploads/2015/08/decreto_etiquetado_alimentos_2015.pdf

[47] Processed foods containing ingredients that aid specific bodily functions in addition to being nutritious.

increase traceability and accountability and improve food safety. Zoonotic diseases, such as avian flu, Ebola and Zika, can also be transmitted into the food supply and need to be combated by governments through improved surveillance mechanisms (Ordaz-Németh *et al.,* 2017; Barr and Wong, 2016; Plourde and Bloch, 2016).

There is a need for education, training on, and monitoring of the prevention of food-borne illnesses among all food supply chain actors and the public. There is also a need for strengthened institutions and policies through an integrated effort piloted by public authorities, not just individual investments. For example, to improve cold chain transport, public investment must also include stabilization of the energy supply, capacity building and control. The HLPE report on FLW further articulates this approach with Tunisia as a case study (HLPE, 2014a).

Traceability (i.e. the ability to trace and follow food, feed or food-producing animals or ingredients, through all stages of production and distribution) helps provide safer foods and better connect producers to consumers. The direct benefits of traceability are supply chain optimization, product safety and market advantages (Regattieri *et al.*, 2007). Consumers can track the full path of food from the origin to the table, know the quality of the food and buy safer food to meet their needs.

Improve food quality across all food systems

There may be voluntary guidelines or policy options for improving the quality and composition of foods in the food environment, e.g. the nutrient profile proposed by the Pan American Health Organization (PAHO, 2016b). Food and beverage industries are working on reformulations, for example, in reducing sugar and sugar replacements. In Singapore, the Healthy Hawkers Programme led to an increase in the availability and affordability of healthier oils for use by street vendors after the Health Promotion Board worked with oil manufacturers to produce a blended oil with 25 percent less saturated fat than the one typically used by vendors (palm oil). To bring down the cost of the blended oil, the Health Promotion Board worked with manufacturers to share logistic services, including storage and delivery resources, which led to the oil being comparable in price to palm oil and, thus, a realistic and feasible alternative (Hawkes *et al.*, 2013).

5.2.5 Evidence gaps for the food environment

Food environments are constantly changing, with consequences for diets, nutrition and health. They need to be monitored in a systematic way (Swinburn *et al.,* 2013). Food environment research is evolving and there are gaps in its theory and empirical evidence, as well as in the metrics and methods to assess food environments and their dynamics, (Turner *et al.*, 2017). Most research on food environments has taken place in HICs and within modern food system types, and much less so in LMICs particularly in traditional or mixed and more complex food system types, where some of the nutrition burden is different (i.e. obesity and diet-related NCDs versus food insecurity and stunting). There is a need for a “data revolution” and more metrics to be able to understand how food environments are changing (UNSCN, 2016a).

Future research on food environments can be envisaged as having three aspects. First, there is a need to document the extent of changes in food environments in different contexts and the specific role of certain drivers (Kimenju and Qaim*,* 2016). The second stream of future research relates to the effect of food environments on nutrition and health. Effects of different aspects and drivers of the nutrition transition on diets and nutrition may differ by context and age group, and may involve several trade-offs (Gómez *et al.*, 2013; Kimenju *et al.*, 2015). There is also a need to understand the effect of complex and dynamic drivers, such as trade and globalization, on diets (Thow, 2009; Kearney, 2010). The third stream of research could investigate how to influence the food environment to supply healthier food products (GloPan, 2016a).

5.2.6 Key points of interventions across food environments

Policy interventions have to be adapted to each food system type and to the local context. **Table 6** provides an overview of some key points of intervention within the three different food system types to improve the quality of the food environments, based on the specific markets associated with those food systems. A single intervention will be insufficient to address the multitude of connected factors that affect the food environment; instead, multiple interventions will be necessary to realize lasting change.

Table 6 Summary of key points for intervening in different food systems to improve food environments

	Availability and physical access (proximity)	Economic access (affordability)	Promotion, advertising and information	Food quality and safety
TRADITIONAL FOOD SYSTEMS *Daily village kiosks* *Daily, local side of the road traditional markets* *Weekly, regional traditional markets*	Promote and invest in small, local food processing Invest in roads, ICT and marketplace infrastructure Improve public transportation to and from markets	Provide incentives and support for stocking nutritious foods		Provide food safety training and certification to merchants Provide incentives for investment in cold storage Ensure that markets have access to water and sanitation
MIXED FOOD SYSTEMS *Supermarkets* *Wet markets* Bodegas *and corner stores* *Fast-food restaurants* *Street food vendors*	Pass zoning laws to incentivize retailers to establish supermarkets in low-income areas Pass zoning laws to reduce the density of fast-food restaurants and food swamps	Provide incentives and support for stocking nutritious foods in supermarkets and *bodegas* and corner stores Provide incentives for street food vendors to sell nutritious foods and use healthier ingredients	Restrict in-store promotions of energy-dense foods of little nutritional value in supermarkets and *bodegas* and corner stores Adopt easy-to-interpret front-of-pack labels on packaged foods Set default options at fast-food restaurants to include nutritious foods Add labelling to menus and boards in fast-food restaurants (kcal, sodium, etc.) Restrict marketing of energy-dense foods of little nutritional value to children	Tax energy-dense foods of little nutritional value Provide food safety training and certification to merchants in wet markets and for street food vendors Improve access to water and sanitation in wetmarkets and for street food vendors Provide incentives for investments in cold storage
MODERN FOOD SYSTEMS *Upscale specialty markets* *Supermarkets* *Farmers markets* Bodegas *and corner stores* *Fine dining* *Fast healthy casual take-away* *Fast food restaurants* *Food trucks* *Street food vendors*	Pass zoning laws to incentivize retailers to establish supermarkets in low-income areas Provide incentives for establishing farmers markets in low-income areas Pass zoning laws to reduce the density of fast-food restaurants and food swamps Provide incentives for food trucks to sell nutritious foods in low-income areas	Provide price incentives for nutritious foods at all outlets Provide incentives and support for stocking nutritious foods in supermarkets and *bodegas* and corner stores Provide incentives for low-income families to purchase fruits and vegetables at supermarkets and farmers markets Provide incentives for food trucks and street food vendors to sell nutritious foods and use healthier ingredients	Restrict in-store promotions of energy-dense foods of little nutritional value in specialty markets, supermarkets and *bodegas* and corner stores Adopt easy-to-interpret front-of-pack labels on packaged foods Ensure accuracy and transparency of statements and labelling related to nutritional value and sustainability Set default options at all restaurants to include nutritious foods Add labelling to menus and boards in all restaurants (kcal, sodium, etc.) Restrict marketing of energy-dense foods of little nutritional value to children Promote healthy diets in schools	Tax energy-dense foods of little nutritional value

5.3 Priorities for orienting consumer behaviour towards healthier diets

Consumers can shape the food supply through their behaviour and demand for specific foods. Demand-side interventions focus on awareness, behavioural change, willingness to pay, knowledge transfer and empowerment to increase demand for nutritious foods and thereby improve dietary patterns. Governments and NGOs can influence consumers' perceptions of the nutrition value (as well as aspects of sustainability, heritage and culture, etc.) of foods by implementing regulation, mass media campaigns, adopting nutrition guidelines and nutrition education (Wilkins, 2005). This section reviews some of the channels through which consumer behaviour can be oriented towards healthier diets.

5.3.1 Nutrition education

Nutrition education has mixed results in improving diets, although it can have greater effect if coordinated with positive changes in food environments or complementary programmes such as home gardens or conditional cash transfers (McGill *et al*., 2015; Lachat *et al*., 2013; Bhutta *et al*., 2008; Ruel *et al*., 2013). Behaviour change communication programmes and social protection programmes that provide insights into how to change consumer behaviour may also play their part.

Strengthen nutrition education

Many countries have recognized the importance of **nutrition education**, often making it mandatory within school curricula, as well as encouraging nutrition education programmes that target cities, schools, workplaces and food providers. Nutrition education not only elucidates the biochemistry of nutrition but also stimulates critical analysis of food choices and helps develop practical skills for a wide range of contexts (e.g. schools, hospitals, care homes and places of work) (Brazil, 2012). The challenge is to adopt a new paradigm for nutrition education. Education should generate autonomy, capacity for reflection and empowerment. In this perspective, nutrition education should promote these same capacities in relation to eating practices, and it needs to address food system and food environment issues.

In LMICs, when agentic interventions (in which individuals rely on information and education to increase their knowledge and skills so as to be able to make healthier choices) are targeted to disadvantaged groups, they can promote healthy eating and reduce social inequalities in diets (Mayén *et al.,* 2016). The difficulty in finding high-quality, evidence-base on nutrition education interventions, including on community-based nutrition education, underscores the need for additional research to measure outcomes and impacts of nutrition education in various groups and contexts (Dollahite *et al.*, 2016). Nutrition education is especially critical for women and has positive impacts on their own and their children's nutrition status (Ruel *et al.*, 2013; Smith, 2003).

Nutrition education is often more efficient when coupled with other interventions. Several studies carried out in South Asia and one meta-analysis have shown that there was a greater impact on maternal and child nutrition outcomes when nutrition education and counselling were coupled with nutrition support in the form of a food supplement, micronutrient supplements or conditional cash transfer (Girard and Olude, 2012; Bhandari *et al.*, 2001; Roy *et al.*, 2005; Christian *et al.*, 2015; Dewey, 2016).

Technology has empowered consumers to take charge of their own education and hence of their own health. The ability to take the best available science and co-create it with consumers to produce real-time data on health outcomes may be transformational for the nutrition research community. HICs and MICs are witnessing increasing use of solutions such as wearable devices, trackers for food and nutrition intake and tech-powered water bottles that monitor water intake. Moreover, the expansion in the use of mobile telephony, and especially of smartphones, has provided new means of increasing exposure to education and behaviour change strategies, from text messages or online diaries to video games (Baranowski *et al.*, 2016).

Encourage consumer behaviour changes through mass media campaigns

Mass media includes newspapers and other printed material, radio, television, billboards, etc. Mass media has an important role in information delivery to a vast majority of the population. Multi-component, community-based media campaigns can be beneficial in promoting nutrition education. For example, the North Karelia Project, in Finland, has provided compelling evidence of the need for

multiple interventions to influence demand and stimulate behaviour change (**Box 23**). An Alive and Thrive study in Viet Nam (Nguyen *et al.*, 2016) found that a combined exposure to mass media and interpersonal counselling together resulted in the highest prevalence of exclusive breastfeeding at 31.8 percent, higher than groups that received only either interpersonal counselling (26.1 percent) or mass media (3.9 percent).

Alive and Thrive has also been involved in similar media campaigns in Bangladesh aimed at reaching mothers, fathers and key community opinion leaders (Sanghvi *et al.*, 2016). It should be noted that with Alive and Thrive, in both Bangladesh and Viet Nam, two groups were compared: an intensive (intensified interpersonal counselling plus mass media plus community mobilization) versus a non-intensive (standard nutrition counselling plus less intensive mass media and community mobilization). There was no statistically significant impact of the intensive Alive and Thrive interventions on child linear growth. Instead, both intensive and non-intensive groups in each country showed rapid and statistically significant reductions in stunting. The research found that other socio-economic characteristics made the largest impact on linear growth such as maternal education, socio-economic status, hygiene and food security (Nguyen *et al.*, 2017). More research is needed on other factors such as maternal age and nutrition, birth spaces and women's empowerment and autonomy to make decisions as key determinants.

Box 23 The North Karelia Project: a media- and education-based community intervention to reduce the risk of coronary heart disease

The North Karelia Project in Finland was implemented between 1972 and 1977 and aimed to address risk factors for coronary heart disease (CHD), given that the region had among the highest CHD rates in the world. The project was aimed at reducing the consumption of butter, whole-fat dairy products, non-lean meats and salt, while simultaneously increasing the consumption of vegetable oils, vegetable-oil-based margarines, low-fat dairy products, lean meats, vegetables, berries and fruits.

A variety of activities were implemented, in collaboration with the Martha Organization,[48] including dietary education via posters and leaflets, newspaper and radio coverage, and the involvement of primary care doctors and nurses, in schools and other community groups, as well as supermarkets and the food industry. This involved development and distribution of healthier, easy-to-prepare recipes. Collaboration with the food industry in reducing and modifying the fat and salt content of commonly eaten foods involved dairies, meat processors and bakeries. Diets improved substantially, and there were declines in blood cholesterol and blood pressure. These changes later coincided with reductions in CHD rates: 73 percent in North Karelia and 65 percent in the whole country from 1971 to 1995. Given the programme's success, it was later expanded nationally, and additional complementary policy approaches were implemented.

Sources: Pekka *et al.* (2002); Puska and Ståhl (2010).

Encourage consumer behaviour changes through social and behaviour change communication

In many LICs, there is a concerted effort to change behaviour and demand through social and behaviour change communication (SBCC) and social support interventions. SBCC is the use of communication to change behaviour including service utilization, by positively influencing knowledge, attitudes and social norms. More than just an advertisement or mass media, SBCC coordinates messaging across a variety of communication channels to reach multiple levels of society (HC3, 2017).

According to Pelto *et al.* (2016), SBCC interventions are often delivered through public health messaging and programmes, with a minor role of mass media. SBCC is considered to be of crucial importance in stimulating community engagement and buy-in, ultimately influencing individuals' behaviour and demand (Bhutta *et al.*, 2013).

In Burkina Faso, for instance, Helen Keller International paired a nutrition and health behaviour change communication programme with a homestead food production intervention, and found that it improved caregivers' knowledge of infant and young child feeding practices. It also improved several child health outcomes including diarrhoea, anaemia and haemoglobin levels (Olney *et al.*, 2015). In

[48] The Martha Organization was founded in Finland in 1899 to promote well-being and quality of life in the home. It focuses on: food and nutrition; home gardening and environmental protection; household economics and consumer issues. https://www.martat.fi/in-english/

Kenya and Ethiopia, in order to increase adherence to calcium and iron-folic acid supplementation among pregnant women, a local support system was developed using an "adherence partner" (i.e. someone helping the pregnant woman to adhere to the regular supplement regimen at home). (Martin *et al.*, 2016). In Haiti, “positive deviants” or caregivers in the community that had well-nourished children despite limited household economic resources, were paired with mothers with poorly-nourished children, and served as a liaison between the nutrition clinic and community (Bolles *et al.*, 2002).

Two systematic reviews showed that multi-component behaviour-changing interventions that incorporate diet, physical activity and behaviour change may be beneficial in achieving small, short-term reductions in BMI in children aged six to eleven years (Mead *et al.*, 2017) but less so in overweight and obese adolescents (Al-Khudairy *et al.*, 2017) largely because the quality of evidence was very low, limiting confidence with inconsistent study results.

To enhance the positive effects of SBCC, more precision is needed in identifying effective delivery mechanisms that are context-specific, along with agreed-upon strategies for communicating key messages.

Develop food-based dietary guidelines (FBDGs) for healthy and sustainable diets

Eighty-three countries worldwide have developed FBDGs that can be used by health and nutrition professionals to provide dietary advice, adapted to local cultures and contexts. These guidelines can also inform food provisioning. For instance, in the United States of America, national guidelines form the basis of Federal food and nutrition assistance programmes such as school meals programmes. In fiscal year 2012, more than 31.6 million children each day received their lunch through the National School Lunch Program (USDA, 2013). In Brazil, in 2014, 42.2 million students received daily meals planned according to the national dietary guidelines and prepared with products provided mainly by small farms.[49]

Ensure that social protection programmes lead to improved nutritional outcomes

Governments and NGOs can influence consumer perceptions of the nutritional value of foods by providing social protection programmes that adopt nutrition guidelines, and by introducing nutrition education (Wilkins, 2005). Social protection programmes such as cash transfers and school feeding programmes can substantially contribute to the realization of the right to adequate food when implemented from a rights-based approach (Sepúlveda Carmona *et al.*, 2012), including respecting the principle of equality and non-discrimination, transparency, participation and accountability.

Cash transfers (CTs) have been effective in terms of improving nutrition outcomes (Rasella *et al.*, 2013; Lagarde *et al.*, 2007; Bastagli *et al.*, 2016). Many studies examining the impact of CTs on diet and nutrition outcomes have found improvements in dietary diversity, while a smaller number have shown improvements in anthropometric indicators (Bastagli *et al.*, 2016). However, given the shifts in the burden of disease from undernutrition to overweight and obesity, CT programmes will need to be continuously monitored to ensure that there are no unintended consequences regarding excessive weight gain.

Conditional cash transfer (CCT) programmes are also important, and Mexico’s Oportunidades Program, which combined stipends conditional on ensuring school attendance and seeking preventative medical care, was associated with a lower prevalence of stunting, lower BMI for age percentile and a lower prevalence of overweight. Although there were significant improvements in children, there were unintended consequences among adults – a doubling of cash transfers was also associated with an increased BMI, higher diastolic blood pressure and higher prevalence of overweight and obesity in participants (Fernald *et al.*, 2008a, 2008b).

5.3.2 Food acceptability

In addition to food availability, access and affordability, the acceptability of food can also influence consumer diets. Acceptability can be influenced by the promotion of specific foods and diets as well as by consumer preferences. These preferences can also be influenced through advertising and

[49] For more details on Brazilian national school meals programmes, see: http://www.fnde.gov.br/programas/alimentacao-escolar

marketing activities as well as by product branding (Boyland and Halford, 2013). Food preferences are associated with dietary intakes (Drewnowski and Hann, 1999): consumers are more likely to consume the foods they consider more acceptable.

The private sector has a strong role to play in increasing the acceptability of foods by producing packaged foods that are nutritious, and can make it more convenient for people to cook and eat healthy meals. For example, some companies sell bagged, cut up or shredded vegetables that can easily be added to salads or cooked: bagged salad mixes and cut up fruit such as apple slices and berries. Frozen vegetables and fruits are also a way for people to have more convenient healthy options that are less perishable but require cold storage.

Currently, large amounts of produce are wasted simply because they do not meet an aesthetic standard that retailers require. While this is a more significant problem in HICs, it also occurs in LMICs. These "ugly" fruits and vegetables are safe and, in some cases, may even be more nutritious than their more "attractive" counterparts. Large retailers have started selling more ugly produce – including Intermarché in France, for example, which introduced the practice in 2014. The produce did not sell well at first, but sales improved after the retailer launched an advertising campaign (Cliff, 2014). In France, mass media campaigns are used to fight food waste by providing imperfect fruits and vegetables at a discount (Di Muro *et al.*, 2016).

5.3.3 Social norms and traditions

Consumer preferences are shaped by a variety of factors including social norms, taste, culture and convenience. Social norms and cultural traditions shape the food that is produced and prepared and also influence our eating preferences.

More research is needed on measuring affordability, convenience and desirability from the consumer's perspective. These are influenced not only by the quality of food and the marketing around those foods, but also by the social norms associated with food (UNSCN, 2016a). Not enough is known about how consumers' attitudes and food practices evolve in response to better information about nutrition and healthy diets, especially in reaction to the plethora of opinions, advice and information now available on the Internet, so this will also continue to be a research area of interest in the future.

This section highlights the evidence that is available around social norms, including traditional food cultures, food preparation and the importance of women as the nutritional providers of families.

Promote traditional food cultures as a way to improve health and nutrition status

Some countries and regions are actively promoting the retention of traditional food culture. In South Korea, for example, concern from the government, scholars and citizens about the growing obesity epidemic triggered a campaign to protect and conserve the traditional Korean diet. The government publicized and conserved native local foods and developed dishes using local agricultural products to stimulate local economic growth and protect local farming. A vegetable- and fruit-based diet was promoted by means of a public relations and events campaign. The result was an increase in vegetable and fruit consumption and a decline in obesity rates (Lee *et al.*, 2002).

Promote traditional food preparation practices and cooking skills

Indigenous peoples' knowledge systems regarding food and methods of preparing food often impart nutritional benefits,[50] are inherently valuable in their local context, and should be protected and promoted through a rights-based approach. Soaking and sprouting seeds increase the nutritional content by increasing the bioavailability of vitamins and minerals. Fermenting foods also increases bioavailability, adds healthy probiotics and makes nutritious foods more shelf-stable. Drying increases shelf stability and, while some vitamins are lost, many remain. It is important to preserve these methods and ensure that they are not lost due to modernization (FAO, 2013e).

Cooking skills are also an important determinant of how often people cook and how healthy their diets are. Several studies have found that learning cooking skills either among school age children or in adults results in consumption of healthier diets, preparing foods and socializing around food with

[50] For instance, the Maasai bolster their nutrition by directly consuming or adding to their mainly animal-sourced diet certain herbs with medicinal properties. Their indigenous knowledge system includes optimal ways and times for them to prepare and consume these herbs (FAO, 2009).

families (Lautenschlager and Smith, 2007; Hartmann *et al.,* 2013; Yuasa *et al.,* 2008; Gillman *et al.,* 2000). Women can play a critical role as decision-makers in improving the nutritional outcomes of their families due to their social role in childcare and household food preparation in many societies. They can serve as the nutrition champions of households.

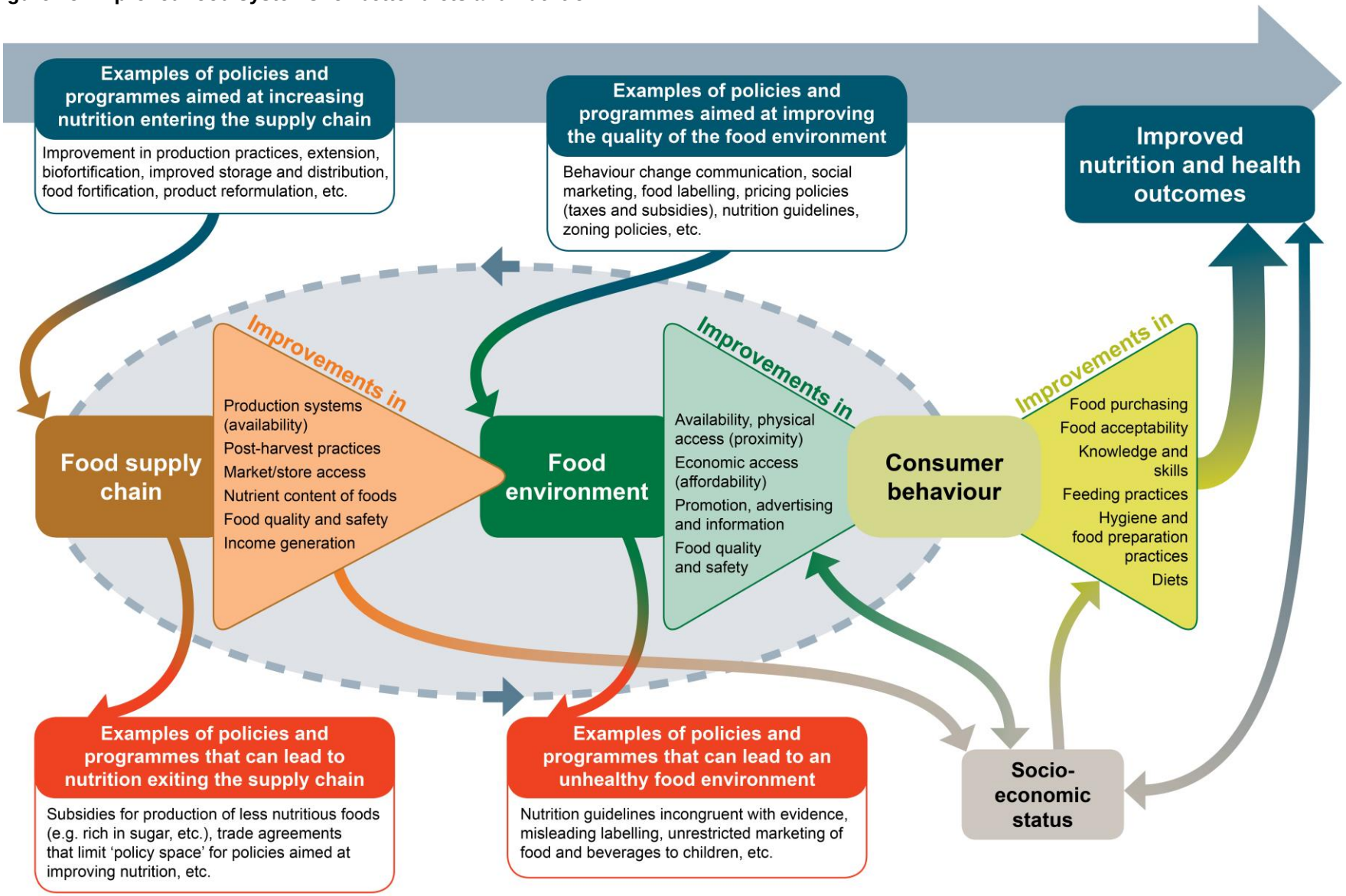
5.3.4 Evidence gaps in consumer behaviour

In the context of shifting food systems and globalization, further research is needed to better understand consumer behaviour and demand, as well as the determinants of that demand now and in the future (Cirera and Masset, 2010; Godfray *et al.*, 2010). A second stream of research is needed on measuring affordability, convenience and desirability from the consumer's perspective. The third stream of research will be on understanding how policies can influence consumer choice and diets in this era of changing food environments, particularly in LMIC settings. In order to better understand the opportunities and constraints that influence food decisions and choices, it is necessary to elucidate the way people's behaviour and daily activities interact with food environments (Turner *et al.,* 2017). Lastly, research is needed to inform policy-makers about how to support behaviour changes towards healthier food choices (Godfray *et al.*, 2010; Haggblade *et al.*, 2016). Coordinated, multi-sectoral actions, including research, policies and interventions, directed towards developing healthier and sustainable diets, are recommended.

5.3.5 Key points of interventions to orient consumer behaviour

Figure 15 depicts the way in which food supply chains interface with food environments and the potential impact pathways that orient consumers towards improved diets and nutrition. There are three main pathways via which supply chains can improve diets and nutrition outcomes, mediated through the food environment: (i) by increasing consumption of nutritious foods; (ii) by decreasing consumption of less nutritious foods; and (iii) by generating income, which can enable consumers to purchase more nutritious foods. Entry points to raise awareness among the different actors in the value chain also stimulate demand for nutritious foods. Economic constraints, lack of knowledge and information, and related lack of demand for nutritious foods are also critical factors that limit access to nutritious foods.

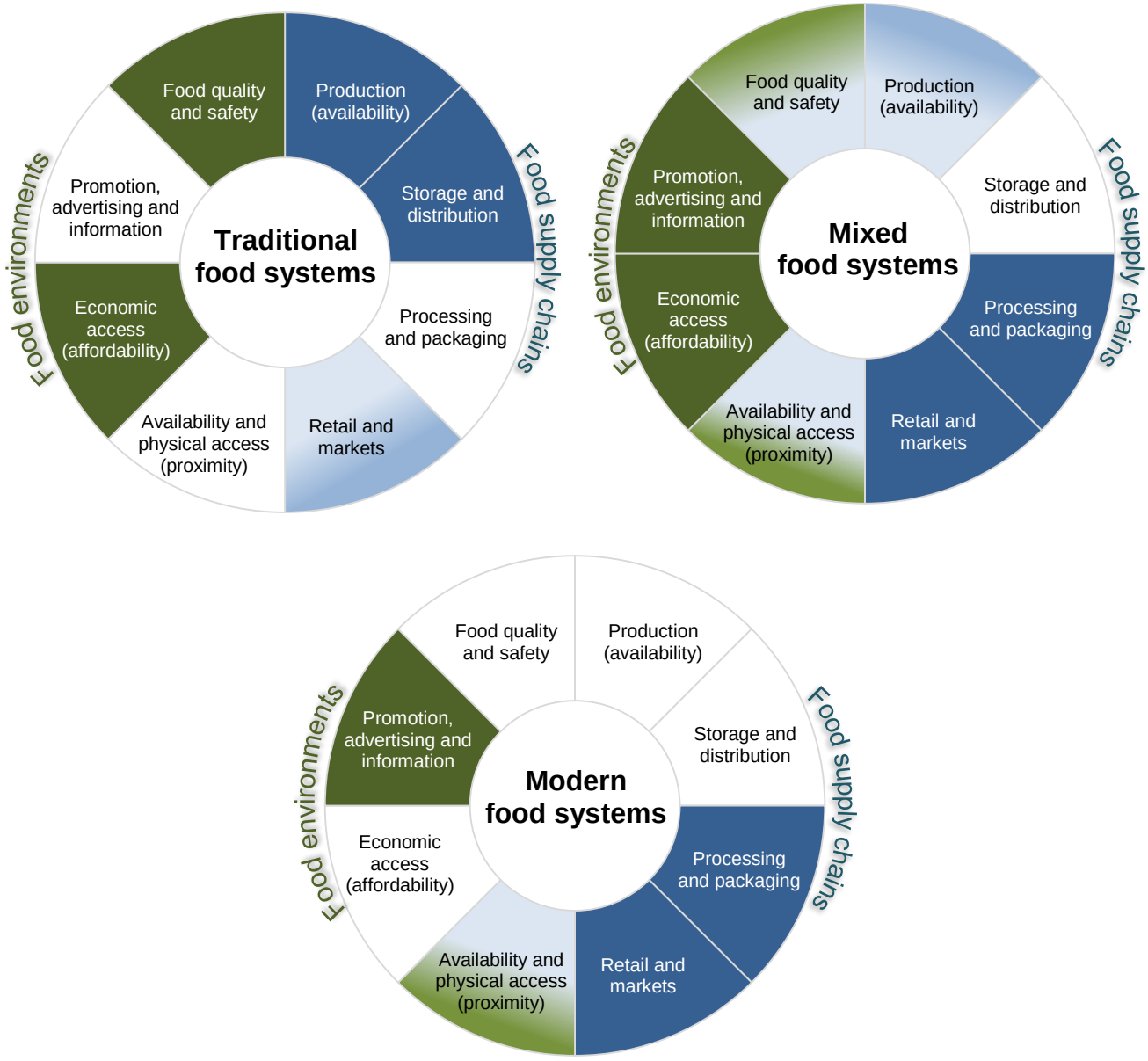
Figure 15 Improved food systems for better diets and nutrition



5.4 Investment and intervention priorities across food system types

Each food system type faces its own challenges and limitations, but all of them have the potential to open specific pathways towards sustainability and to deliver healthier diets that enhance FSN in their local contexts, and/or for all, now and in the future. “Modern” food systems are not the end goal for every food system. Traditional food systems, and their associated knowledge systems, are valuable by themselves and can be a source of inspiration for policy-makers. **Figure 16** summarizes where investments and interventions could be prioritized across the three food system types identified in Chapter 1.

Figure 16 Prioritized investment across food system types



Notes: The right side of the wheel (blue) illustrates the elements of the food supply chain while the left side of the wheel (green) the elements of the food environment as described in Chapter 1.

(1) Darker slices indicate elements of the food supply or environment that need *significant* investment and interventions to improve or change.

(2) Shaded slices indicate elements of the food supply or environment that need *some* investment to improve or change but not critical.

(3) Slices left white indicate elements of the food supply or environment which are important investments but if choices need to be made, they are *less of a priority*.

5.4.1 Traditional food systems

In traditional food systems, policies should focus on availability, and on physical and economic accessibility of high-quality (i.e. containing essential nutrients) diets. On the production side, this might involve strategies that increase the resilience of farmers, especially smallholder farmers who are often net food-buyers, to external shocks, whether natural or human-induced. This might include, for example, strengthening rights to land and other productive resources, improving access to services and resources such as credit, technology, inputs, markets and extension (HLPE, 2013, 2016). Investments in infrastructure and storage facilities that allow for easier transport and safe storage of food commodities, and integration of technologies such as food fortification and food processing, can alleviate the burden that consumers experience in trying to meet their dietary needs.

On the consumption side, though nutrition and health education is essential, it is not sufficient: policies should also focus on affordability of those foods that constitute a healthy diet. Because poor households often spend a large portion of their household budget on food, stabilizing food prices and providing social protection programmes for vulnerable groups (particularly in the light of climate change and increasingly irregular weather patterns) is essential for FSN (HLPE, 2011a, 2012b).

5.4.2 Mixed food systems

In mixed food systems, interventions aimed at improving infrastructure and strengthening food safety will still be important, particularly for the informal food sector. However, mixed food systems could also be improved by a range of interventions, such as the introduction of price incentives (e.g. taxes and subsidies), marketing restrictions, improved labelling, promotions and incentives for the sale of nutritious foods and using zoning incentives to increase access to retailers selling nutritious foods in low-income areas.

5.4.3 Modern food systems

Finally, in modern food systems, physical and economic access to food is not a significant challenge except for the poorest. Interventions for these food systems overlap substantially with the mixed food system and might be easier to implement given the lower importance of the informal sector in those systems.

Within these food systems, policies and programmes should focus on dietary quality and diversity, targeting especially the most vulnerable groups within their respective communities. They should also aim at limiting the consumption of highly-processed and nutrient-poor foods by targeting the industries that produce them (e.g. through marketing restrictions, content restrictions and labelling requirements on ingredients such as trans fats and added sugars) as well as by targeting consumers (e.g. subsidies for, or taxation of, certain foods; nutrition education). Such policies might mitigate some of the negative health consequences generally associated with modern food systems.

5.5 Conclusion

There are many places to intervene within food systems – across food supply chains, within food environments and by influencing consumer behaviour. There is no one-size-fits-all approach, and solutions must be adapted to the different food systems described in Chapter 1 and to each local context. While we need more research across both programmes and policies to address the multiple burdens of malnutrition, evidence is emerging on where to act to shift food supply chains and food environments towards those that facilitate healthier food choices. There is also a need for better understanding of the exogenous drivers that influence not only how food systems operate but also who controls them, and how much power consumers have in making decisions within food environments, bearing in mind that some of the world's poorest and most marginalized groups have effectively very little choice regarding what foods they purchase and consume. The final chapter will discuss how we turn this evidence into action.

6 TRANSLATING EVIDENCE INTO ACTION

Despite the abundance of evidence that nutrition is a critical issue (see Chapter 2) and that positive change is possible (see Chapter 5), and despite the evident positive political will to progress towards more sustainable food systems that deliver healthier diets and enhance FSN, many countries are still struggling to move from intention to action. This requires not only leadership, but also addressing the complexity of food systems through coherent and coordinated policies integrating multiple sectors, including health, agriculture and the environment. Furthermore, better results can be achieved if the determinants of the problems and the consequences of the decisions are properly analysed, and if the principles of human rights inform the decisions made.

This chapter aims at helping policy-makers translate evidence into action, by reviewing: the motivations for action; the main obstacles that prevent effective action; and, the enabling conditions to progress towards more sustainable food systems.

6.1 Motivations for action

What are the motivations to take the evidence and best practices and put them into tangible action that will enable food systems to deliver healthier diets and improve FSN?

The scale of the burden raises alarms

As shown in Chapter 2, the multiple burdens of malnutrition are enormous and impact every country. Chapter 2 also shows that, while hunger and undernutrition remain critical issues in many countries, other forms of malnutrition present an increasing challenge that affects all the countries. To achieve SDG2, governments will thus have to address simultaneously all forms of malnutrition.

Letting the multiple burdens of malnutrition continue to grow would have massive consequences on society and would make it incredibly difficult to achieve not only SDG2 but most of the SDGs. Civil society has been an important advocate in highlighting malnutrition issues, but the involvement of all stakeholders is needed to end hunger and achieve FSN for everyone.

The societal costs are considerable

The social and economic costs described in Chapters 1 and 2 should, alone, elicit action as. These costs are greatest for the most vulnerable but it is the most powerful who must act. As World Bank President Kim (2017) said: “Make neglect hurt for the powerful.” Addressing malnutrition does not have to be expensive but will require societal changes. Better legislation and nutrition-sensitive policies take political will, commitment and accountability.

Diets need to be improved

As shown in Chapter 3, poor diet is the number one risk factor driving the world’s disease burden (Forouzanfar *et al.*, 2015). According to the GloPan, three billion people from 193 countries now have low-quality diets and “enhancing the ability of food systems to deliver high quality diets is a choice that is well within the grasp of policymakers” (GloPan, 2016a). This will require concerted actions across food supply chains and food environments, as well as across the drivers of food system changes described in Chapter 4.

Solutions and evidence to act are available

As shown in Chapter 5, although there are gaps in understanding the effects of diets on nutritional and health outcomes, and consumer behaviour towards food choices, some solutions already exist to improve these outcomes. Policy-makers, with the support of researchers, advocates and practitioners, should invest in these solutions and adapt them to their own national and local context and needs.

There is a dedicated decade for nutrition

In April 2016, the United Nations General Assembly proclaimed a *UN Decade of Action on Nutrition* from 2016 to 2025 (UN, 2016). The main objective of the Decade is for governments, international government organizations (IGOs), civil society, the private sector, academia and other actors to define commitments to advance the global nutrition agenda, within the 2030 Global Agenda for Sustainable Development and framed by the Rome Declaration on Nutrition. The Decade is an opportunity for consolidating and aligning nutrition actions and facilitating policy processes across the areas identified in the Second International Conference on Nutrition (ICN2) Framework for Action for the commitments

of the Rome Declaration on Nutrition (FAO/WHO, 2016). The CFS can be an active partner in the realization of the objectives of the Decade.

The integrated nature of nutrition calls for better policy coherence across sectors

The United Nations Standing Committee on Nutrition (UNSCN) argues that for better coherence, a shift is needed from global nutrition governance to intersectoral governance for nutrition (UNSCN, 2017). The traditional focus of the agriculture sector on dietary energy supply has limited the potential for agriculture to address the problems of micronutrient deficiencies and obesity. The health sector has always considered nutrition a minor issue as compared to fighting infectious diseases. Going forward, at minimum, the agriculture and health sectors need to take the lead, and be equal partners in improving diets and nutrition.

6.2 Barriers and obstacles that prevent action

What are the barriers and obstacles to take the evidence already available and translate it into tangible action that will enable food systems to deliver healthier diets and improve FSN?

6.2.1 Failure to recognize the right to adequate food

The human right to adequate food establishes the seven 'PANTHER' principles that should govern decision-making and implementation processes: **P**articipation, **A**ccountability, **N**on-discrimination, **T**ransparency, **H**uman dignity, **E**mpowerment and the **R**ule of law (FAO, 2011c).

The 2030 Agenda highlights the need to approach nutrition and food systems from a rights-based perspective, but this is not always prioritized in practice. Countries have committed to "end hunger, achieve food security and improved nutrition and promote sustainable agriculture" (SDG2).[51] Achieving these clearly articulated objectives requires an integrated approach that:

- focuses on the right to adequate food of poor and vulnerable groups and helps secure their incomes and FSN;
- recognizes food collection or production as the primary source of income and jobs for many poor rural households;
- engages all stakeholders in active, transparent and thoughtful dialogue and attempts to seek consensus through participatory processes ensuring no one is left behind;
- anchors entitlements to food within a framework of laws and institutions, institutionalizes democratic processes and strengthens the capacities of responsible individuals and institutions to carry out their duties as expressed in local, national and international rules, policies and programmes (FAO, 2012c).

6.2.2 Power imbalances across food systems

Power across food systems, particularly at the national level, needs to be rebalanced. Currently, there are many power struggles in food systems that shape food governance.

"Accountability is ultimately about governance and power and determines how and why decisions are made, who makes decisions, how power is used, shared, and balanced, whose opinions are important, and who holds whom to account" (Swinburn *et al*., 2015). The progressive concentration of much of the economic power in the hands of transnational food corporations over the past decades has limited the domestic policy space and political power of local and national governments. In turn, this has reduced governments' ability to protect and promote the right to adequate food of their people.

Governments face intrinsic tensions in their efforts to support industrial innovation and attract investment by creating stable policy environments, and by implementing innovative policies to incentivize the production and consumption of healthy foods (Thow and McGrady, 2013). In the context of a rights-based approach, those most impacted by inequitable, dysfunctional food systems and unhealthy food environments include low-income consumers, the rural and urban poor, smallholder and subsistence farmers and indigenous peoples.

[51] https://sustainabledevelopment.un.org/sdg2

The food and beverage industry sees its marketing and advertising, product placements, pricing policies and packaging in food environments as a response to consumer demand. This view assumes that it is up to the consumer to make choices, whether healthy or unhealthy. However, the balance of power is highly in favour of multi-national corporations at present and greater efforts must be made to create healthier food environments for consumers (Baker and Friel, 2014; Malik *et al.*, 2013; Monteiro and Cannon*,* 2012).

The 2016 interim report by the UN Special Rapporteur on the right to adequate food suggests that "a holistic approach to nutrition requires national policy-makers to create an environment conducive to nutritious, healthy diets, including through education and dietary guidelines. A comprehensive approach should encourage adjustments in the food supply and changes in food systems to increase the availability and accessibility of healthier food that is both sustainable and nutrition-sensitive".

Governments can use fiscal instruments (like taxes on SSBs and unhealthy foods) and regulatory mechanisms (such as bans) to support healthier diets and hold food industry accountable. According to Swinburn *et al.* (2015), "power and accountability structures need to be aligned in such a way that governments and civil society, acting on behalf of public interest, outweigh the interests of the private sector". The efficacy of the technical solutions also depends on the political will and priority given towards ensuring that nobody's right to adequate food is denied. Social movements and civil society organizations (CSOs) can act to rebalance the power across the food system geared towards healthy systems in the public interest of those whose voice is not being heard.

6.2.3 Conflicts of interest

The concept of "conflicts of interest" (COIs) can be defined in various ways, and can apply both to individuals and to institutions (Rodwin, 1993; Thompson, 2005; Richter, 2005). COIs related to food systems have an impact on the kind of food information that is available, the types of diets people adopt and, consequently, on health and nutritional outcomes of food systems.

COIs occur when the policies and practices of individuals, organizations or industry conflict with public health and nutrition goals (Bellows *et al.*, 2016). Vested interests influence national and international norms and policies, scientific evidence and consumer preferences – for example, by interfering in decisions of public interest, breaking the International Code of Marketing of Breast-milk Substitutes (discussed in Chapters 3 and 5), or through marketing and advertising of unhealthy foods to children (discussed in Chapters 1 and 5) (Stuckler and Nestle, 2012; Goldman *et al.*, 2014). There is now increasing awareness of how food systems are affected by commercial interests but governance and accountability mechanisms still have to be developed to better identify, acknowledge, prevent and address COIs.

Certainly, the private sector plays a role and has substantive potential to help deliver improved nutrition. However, Gillespie *et al.* (2013) consider that efforts to realize this potential have so far been hindered by a limited trust. They also call for better documentation of best practices and underline the need for additional independent evaluations of the involvement of the private sector in nutrition. Yach (2014) and the Global Nutrition Report (IFPRI, 2015a) suggest that open discourse and partnering are essential between the public and private sectors if we are to tackle complex food and nutrition issues. This must be based on an agreed ethical viewpoint. It is also likely to take time to build trust and understanding between different partners (either public, private or coming from civil society), as well as a clear understanding of the strengths and limitations that each partner brings to the discussion.

In order to prevent COIs, governments should establish guidelines on who should participate in groups responsible for policy-setting and normative work, rules on disclosure and the transparency of interests, and policies to manage COIs (WHO, 2016b). For those businesses that do want to improve nutrition, there should be an enabling environment that encourages partnership.

Scientists too can experience COIs. The nutrition scientific community has been increasingly scrutinized for where it sources its funding. COIs in research funding can undermine public trust in scientific evidence (Kearns *et al.*, 2016). A review of scientific articles found that articles based on research not funded by the food and beverage industry were four to eight times more likely to report an unfavourable outcome of SSBs on health than those funded by this industry (Lesser *et al.*, 2008; Bes-Rastrollo *et al.*, 2013).

However, there is a potential for all research and its funding, regardless of its source, to bias behaviour (Rowe *et al.*, 2009): neither is all industry-funded research biased (Wilde *et al.*, 2012), nor is all non-industry-funded research unbiased. Faithful reporting, acknowledging the limits of research studies and objectively evaluating evidence can help maintain scientific integrity (Cope and Allison, 2010).

Numerous initiatives have been developed to define appropriate standards of acceptable conduct in research (WHO, 2016b). The International Life Sciences Institute worked on guidelines regarding industry-funded research to prevent COIs. Those guidelines include criteria on such things as: funding transparency; control of private research by independent scientists; remuneration that is not tied to research outcomes; written agreement on the publication of the results; and full disclosure of financial interests and professional affiliations (Rowe *et al.*, 2009): Another important measure to increase transparency in the research process and dissemination of results was the decision of the United States of America's National Library of Medicine[52] (which serves as a global centre of information innovation and hosts the largest repository of electronic research publications) to add information about COIs to the abstracts of articles submitted to the bibliographic database of life sciences and biomedical information, MEDLINE (NLM, 2017).

6.3 Enabling conditions to improve nutrition and food systems

What enabling conditions are necessary to take the evidence and best practices and put them into tangible action to deliver healthier diets and improve FSN?

6.3.1 Build a supportive political environment

Multi-sectoral coordination

Governments need to be capable of coordinating policy interventions across sectors to deal with the multiple causes and consequences of malnutrition (Acosta and Fanzo, 2012). Nutrition and food systems require multi-sectoral and multi-dimensional interventions. At the national level, the activities of many ministries need to converge to achieve sustainable food systems that deliver good nutrition. Multi-sectoral, multi-stakeholder mechanisms encourage various ministries and departments to support nutrition-sensitive interventions and to avoid that one ministry's policies undermine another's. Such mechanisms often require the endorsement of the highest political body in a given country, as well as the effective participation of a range of stakeholders, including national and international organizations from civil society, indigenous peoples and the private sector, the United Nations, donors and researchers. This participation should cover all dimensions of the food system from production to consumption. It must also ensure that the marginalized and the most vulnerable social groups participate effectively in the process of defining strategies to prevent and combat malnutrition in the overarching framework of a rights-based approach.

Sometimes, the sheer number of agencies, actors and sectors involved in addressing the problem leads to unnecessary competition (Gillespie *et al.*, 2013; Morris *et al.*, 2008). Efforts are now being made to stimulate the convergence of governance systems within the nutrition space.[53] At the global level, the Committee on World Food Security (CFS) is the foremost inclusive and evidence-based international and intergovernmental platform for policy convergence and coordination on FSN-related issues.[54]

Executed accountability

All FSN stakeholders and governments must be accountable for meeting the needs of the most vulnerable. Governments must play a strong role in reshaping food systems so that they provide diversified and nutritious diets for both current and future generations, while ensuring secure livelihoods for small-scale food producers and preserving and strengthening ecosystems and biodiversity.

Yet, if no one "owns" food systems, how can anyone be held accountable? Of course policy-makers, CSOs and, in most cases, even governments cannot autonomously own all the components of food systems in today's world. Rather, they have a responsibility to exercise a positive influence over the owners of the constituent parts of the system, which is something very different. They have, in other words, a responsibility of custodianship. From a human rights perspective, states have an obligation to establish policies and processes that respect, protect and promote the right to adequate food.

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[52] https://www.nlm.nih.gov/

[53] Within the UN system, the UNSCN is a dedicated platform where UN agencies can establish a dialogue, design joint global approaches, and align their positions and actions on nutrition. See https://www.unscn.org/

[54] See http://www.fao.org/cfs/home/en/

Considering this perspective, states should have a central role in global and national accountability and governance of food systems. This governance gives priority to the most vulnerable groups, provides social participation, renders accountability and acts on the parameters of the Rule of Law (De Schutter, 2014).

The essentials for an effective accountability system are: trust, inclusiveness, transparency and verification; government leadership and good governance; public deliberation; independent bodies monitoring compliance and performance; remedial actions to improve accountability; and capacity to manage conflicts of interest and settle disputes (Kraak *et al.,* 2014). Strengthened accountability systems would support government leadership and stewardship, constrain the influence of private sector actors and reinforce the engagement of civil society in creating demand for healthy food environments and monitoring progress towards the nutrition agenda objectives (Swinburn *et al.,* 2015).

Effective responses

Governments need to provide rapid and effective responses to prevent irreversible damage from malnutrition in all its forms, particularly in humanitarian crises in which children are at high risk of wasting and mortality. This means that governments must understand the current situation of their food systems and environments, who is shaping those, and what their potential consequences are for the health of their populations. Investing in national surveillance systems and technical capacity to ensure the analysis of information in a comprehensive manner to support the planning and monitoring of actions is critical to diagnose issues for FSN. The current scarcity of data prevents governments from identifying and responding to real-time issues (IFPRI, 2016).

As highlighted by Brinsden and Lang (2015), there is an increasing need for strong public health advocacy in which a broad spectrum of determinants is considered. There should also be a focus to ensure that movements and organizations that defend the interests and rights of the most vulnerable and disadvantaged groups are guaranteed access to information and meaningful and effective participation with public authorities (Recine and Beghin, 2014; Valente, 2016). Efficient advocacy and multi-level governance are synergistic. **Box 24** presents Brazil's experience with nutrition governance over the past 15 years.

Box 24 FSN governance for better results: the case of Brazil

Brazil achieved important results in the past decade in reducing inequalities and hunger. These results were traceable back to the 1990s, when a large movement mobilized Brazilian society to act against hunger. That movement was one of the pillars of what would later become the main priority of the government in 2003, the Zero Hunger Strategy.

Brazil's Zero Hunger Strategy[55] was based on a complex and multi-dimensional "food and nutrition security" (FNS) concept understood as the realization of the human right to regular and permanent access to healthy food, in sufficient quantity, without compromising the fulfilment of other basic needs, and having as its foundation healthy nutritional habits that respect cultural diversity and that are environmentally, culturally, economically and socially sustainable. The guarantee of FNS requires not only a set of public policies but also a favourable political environment for its implementation.

In 2006, Brazil introduced a law (No. 11346 of September 15, 2006)[56] establishing a FNS National System based on human rights, food sovereignty, intersectorality, social participation, decentralization and international solidarity. The three main pillars of the national system are the FNS Councils, the National Conference on FNS, and the Governmental Intersectoral Chambers.

The FNS Councils comprise representatives of different sectors of civil society (accounting for two-thirds of total participation) and government sectors (accounting for the remaining third). The President is always a representative of civil society. At the Federal level, the Council is an advisory body of the Presidency of the Republic. All its recommendations are sent to the Presidency of the Republic and to the Interministerial Chamber.

As a result of this initiative, programmes have been designed based on a comprehensive, systemic and participatory approach, and they stimulate collaboration between different sectors, and the forging of closer links between food production and healthy eating. This process of listening and systematic negotiation has taken the agenda of global food security and nutrition to a level that probably could not have been achieved by traditional processes of public policy implementation.

Sources: Leão and Maluf (2012); Burlandy *et al.* (2014); Rocha *et al.* (2016).

[55] http://www.inter-reseaux.org/IMG/pdf/Note_FaimZe_ro_Sept2012_EN_vp.pdf

[56] http://www4.planalto.gov.br/consea/conferencia/documentos/lei-de-seguranca-alimentar-e-nutricional

6.3.2 Invest in nutrition and food systems

Donors and governments must allocate more resources for nutrition and invest in fighting all burdens of malnutrition. To address undernutrition, 1.7 percent and 0.4 percent on average of general government expenditures are spent on nutrition-sensitive and nutrition-specific interventions respectively (IFPRI, 2016). There is also not enough investment in obesity and diet-related NCDs, with these receiving less than 2 percent of development assistance for health (Nugent and Fiegl, 2010).

A recent report from the World Bank estimates that "the world needs USD 70 billion over 10 years to invest in high-impact nutrition-specific interventions to reach the global targets for stunting, anaemia in women and exclusive breastfeeding for infants and to scale up the treatment of severe wasting among young children", which is not a very high amount when compared to the USD 500 billion currently spent annually on agriculture subsidies (Shekar *et al.,* 2016).

The World Bank report finds that, unlike many other development investments, investments in nutrition are "durable, inalienable, and portable". They are durable because investments made in early childhood last a lifetime and are inalienable and portable because they belong to that child, no matter what that child does or what that child grows up to be. Moreover, investments in nutrition provide an excellent estimated return of between USD 4 and 35 for each USD invested (Shekar *et al.,* 2016). IFPRI (2014) gives an estimation of USD 16 return for each USD invested for scaling-up nutrition interventions in 40 countries. The Copenhagen Consensus Center (Lomborg, 2014)[57] concluded that nutrition interventions generate the highest returns among a total of 17 potential development investments.

Food systems investments mainly come from the private sector. However, governments and the public sector are the duty bearers for ensuring that the food systems enhance FSN and health for all. Therefore "the public sector should test new ways to leverage its investments and regulatory power to incentivize the private sector to include improved nutrition among its goals. Public investments in food systems should be aligned with other social goals" (UNSCN, 2016b).

6.3.3 Develop human capacity across nutrition and food systems

Human capacity continues to be a serious limiting factor to scaling up the coverage, impact and sustainability of nutrition programmes, particularly among nutrition and food systems actors. Despite some progress, efforts to alleviate malnutrition are hampered by a shortage of necessary skills and leadership capabilities (Shrimpton *et al.,* 2016). High-quality, appropriate training for front-line nutrition workers, programme managers and even policy-makers is often lacking. Today's nutrition professionals need a complex set of technical and leadership skills for roles that involve working in multi-sectoral teams and confronting the multiple malnutrition burdens (Shrimpton *et al.,* 2014).

Because nutrition outcomes depend on multiple sectors, leadership development training needs to occur within multi-sectoral teams so that these are fully aligned when programmes are initiated and subsequently scaled up (Jerling *et al.,* 2016). Nutrition professionals must be trained in key concepts in different fields, including agriculture, environment, social protection and sanitation in order to be able to advocate coherent, cross-sector interventions and investments. This involves building the necessary technical, managerial and leadership capacities (Mucha and Tharaney, 2013).

Some ideas to build these capacities include: designing an '"executive training" workshop for programme staff; expanding existing intensive nutrition workshops for development practitioners and programme managers; using technology-driven platforms for front-line workers; promoting already existing open-access nutrition-specific and -sensitive massive online open courses (MOOCs) for researchers and evaluators; initiating a North–South and South–South global nutrition consortium of universities; and using mobile technologies to support "anywhere, anytime" learning (Fanzo *et al.,* 2015).

There is a need to think about new ways to build capacity using less formal mechanisms of education through vocational training and certifications to enhance levels of professionalism. There should also be increased opportunities for movement both away from and into nutrition as a potential career option.

[57] http://www.copenhagenconsensus.com/

6.3.4 Support movements, coalitions and networks

Social movements, coalitions and networks are critically important to any major societal transformation, as they help create the necessary institutional and system capacity. Movements may operate at the grass-roots level or they can be global, like the Scaling Up Nutrition (SUN) Movement (**Box 25**). There are food movements that are driving change in certain countries through CSOs or the public – Brazil being a good example (Acosta and Fanzo*,* 2012). Other such grass-roots movements focus on the growing concern about our health and the globalized food system (Friedmann, 2005). These movements, coalitions and networks need to be further supported, funded and linked together if change is to come about.

While such broad coalitions are built, the role that each stakeholder plays also needs to be clearly understood. For instance, CSOs have an important role in advocacy (Gillespie *et al.*, 2013). It is also important for governments to create opportunities for dialogue with civil society. In many countries, the participation of CSOs has encountered difficulties. Active and informed participation is one of the principles for the guarantee of human rights, including the right to adequate food. Better public policy results when these voices are supported (Swinburn and Moore, 2014).

The challenge of confronting malnutrition in all its forms will require new nutrition governance mechanisms from the global to national and local levels, as well as more intense coordination across sectors and levels*.* Social movements and CSOs can play different roles in this process, some of which are listed below:

- Social movements and CSOs reinforce the role and voice of small farmers, pastoralists, agricultural and food workers, small fishers, forest-dependent people, indigenous peoples, landless people, rural women and young people as the main producers of food around the world. They stress the urgency of recognizing that small-scale food producers operating sustainable and resilient local food systems can contribute significantly to the prevention of malnutrition.
- The private-sector mechanism (PSM) and the civil society mechanism (CSM) of the CFS are important in representing the concerns and views of both the food and beverage industry and CSOs. These mechanisms must find ways through transparent cooperation to work together with governments in the context of joint goals for healthy diets and sustainability.
- Digital technology has enabled organizations, institutions and individuals to express their opinions to a global audience. Communities of practice (CoP) allow different professionals to exchange information and share experiences online and should be further supported (Ranmuthugala *et al.,* 2011).There are numerous networks, blogs and Websites that address the subject of food and nutrition and link various institutional interests. These digital platforms can be used for debate, information and capacity-building, for encouraging accountability, and for monitoring actions.

Box 25 The Scaling Up Nutrition (SUN) Movement

The Scaling Up Nutrition (SUN) Movement, was launched in 2010 to fight hunger and malnutrition. The principles that drive the SUN's actions are transparency, accountability, inclusiveness, human rights, negotiation, cost-effectiveness, communication, integrity, ethical behaviour and mutual respect. The SUN's work focuses on the first 1 000-days of life and on nutrition-sensitive approaches to tackle the underlying causes of malnutrition as well as on nutrition-specific interventions to tackle its direct manifestations (SUN, 2011). At country and global levels, SUN's activities in countries are supported by four networks: civil society, the UN, businesses and donors. Currently 59 countries are involved in the SUN Movement.[58]

In 2014, an independent evaluation of SUN was carried out to assess the value it adds to the global effort to scale up nutrition. The main conclusions were that the initiation has been successful in terms of advocacy and mobilization, but evidence as to its impact on nutrition has been limited. The report also indicated that the objectives of establishing detailed action plans with monitoring systems, clear goals and an increase in the capacity to raise funds have not yet been achieved (Mokoro, 2015).

Based on these results and recommendations and a consultative process involving the SUN countries, multiple UN and donor agencies, international and national non-government organizations and the private sector, the SUN Movement Strategy and Roadmap were developed (2016–2020) (SUN, 2016). These reinforce the importance of nutrition as being fundamental to the full achievement of the SDGs.

Sources: SUN (2011, 2016); Mokoro (2015).

[58] See: http://scalingupnutrition.org/ (accessed August 2017)

6.3.5 Develop new partnerships

Successfully combating the multiple burdens of malnutrition will depend on the engagement of multiple stakeholders from public and private sectors and from civil society.

Multi-stakeholder partnerships (MSPs), including public–private partnerships (PPPs), combine resources and expertise of different categories of stakeholders and might be able to address complex issues that cannot easily be solved by a single actor. MSPs are identified in SDG17 (in particular of targets 17.16 and 17.17) as a central tool in the implementation of the 2030 Agenda. They could be key in sharing experiences, technologies and knowledge, and in mobilizing domestic and foreign public and private resources.

There is a need for dialogue between governments and the private sector. The private sector is primarily seen as part of the problem, but it can and should also be part of the solution. The terms of engagement should be those led by government, and the private sector needs to be steered to understand government priorities. While it may be a challenge to build trust between the public and private sectors, and to avoid conflicts of interest, PPPs have the potential to include multiple perspectives and resources to address complex topics of mutual interest, particularly when thinking about the importance of food systems for health and sustainability (FAO, 2016f; IOM, 2012). However, the success of PPPs may be impeded by constraints such as: lack of an adequate legal and regulatory framework; lack of the prerequisite technical skills; unfavourable investor perception of country risk; small market size; limited infrastructure; and limited financial markets (Venkatesan, 2016). Improving partners' capacity to design, manage and participate in PPPs is an important success factor. Transparency and accountability are desirable at all stages, and good governance is crucial for PPPs to work effectively (Morredu, 2016).

A forthcoming HLPE report (2018), will explore in more depth this notion of MSPs, looking at both processes and outcomes. This report will examine and evaluate their potential roles in financing and improving FSN in the framework of the 2030 Agenda, as well as their contribution to nutrition and food systems governance at different scales.

6.4 Conclusions and key messages

In the face of the myriad of dietary and malnutrition challenges that lie ahead, a coordinated, multi-sectoral, enabling environment and response are necessary for true change across food systems. This requires dialogue between all relevant sectors and actors, including policy-makers, development actors, civil society, donors, the private sector, and consumers and producers. There are many avenues to achieve this dialogue across different platforms. However, better governance and accountability are required. This will not be easy, and there are controversies and COIs that must be addressed if we hope to achieve the 2030 Global Agenda for Sustainable Development and the objectives set out by the UN Decade of Action on Nutrition (UN, 2016).

The UN Decade of Action on Nutrition provides the political legitimacy to "confidently pursue its strategic objectives, and to support UN agencies and other key multi-stakeholder actors in their pursuit of coherent policies and activities that empower national governments to address malnutrition in all its forms" (UNSCN, 2017). All stakeholders must exert their influence to reverse the current malnutrition burden trends.

Every country in the world is impacted by some burden of malnutrition that will affect national growth and sustainable development (FAO, 2013a; GloPan, 2016b). The nutrition community must seize this moment to make the Decade meaningful, action-oriented and impactful.

CONCLUSION

Ending hunger remains critically important but other forms of malnutrition have become widespread and must also be tackled. The challenge is to provide enough food for all without relying on a strategy of producing overabundant energy-dense and nutrient-poor foods in unsustainable food systems.

Poor diet is the number one contributor to the global burden of disease. Without health, food security and nutrition, development is unsustainable. Actors within food systems and food environments are not currently doing enough to facilitate healthier dietary choices. Foods that support healthy diets are often too expensive or simply not available. The demand for healthy food is not as strong as it should be. And the enabling environment is not supportive enough of stakeholders that want to change food systems for better nutrition.

Current food systems have dramatic effects on human and planetary health and, if current trends continue, the current development process will not "self-correct" this problem neither in the short nor even in the medium term. Nevertheless, this report demonstrates that humans, whether producers or consumers, can profoundly affect the ability of food systems to promote nutrition and health and to be more sustainable. As shown in Chapter 5, there are many choices regarding legislation, policy, investments, norm-setting and technology that can contribute to improve the health and nutritional outcomes of food systems. The evidence assembled in this report shows that the past does not have to be a prologue: LMICs can avoid the mistakes made by many of the HICs.

In this perspective, much of the leadership needs to come from governments and intergovernmental organizations. They should also set up the enabling conditions for all the stakeholders (farmers, private companies, CSOs and consumers) to play their own role, and to promote and adopt healthier and more sustainable diets that should be made affordable and accessible. Food systems are sprawling networks of actors responding to a wide array of incentives – all actors have a vital part to play in the pivoting of food systems towards, rather than away from, nutrition. These actions are different for each nation and for different areas within each country. The food system typology proposed in this report is intended to help policy-makers elaborate context-specific solutions.

Action cannot wait. Policy-makers and other stakeholders will have to make feasible but bold decisions, learn from them, and share the learning. The risks of making well intentioned but inappropriate policy choices are much smaller than the risks of using a lack of evidence as an argument for inaction. Unintended consequences may be avoided by monitoring and measuring the impact of policy decisions and making adjustments as may be required to achieve the intended outcomes. Nevertheless, the accumulation of scientific and knowledge-based evidence in the area of nutrition and food systems must be accelerated rapidly. Agriculture and nutrition research funders should pool resources and encourage deeper cooperation between organizations to provide agreed and evidence-based perspectives on food systems choices, from production to consumption.

Food systems face big challenges to improving diets and nutrition around the world but also represent many opportunities: they contain large resource flows, they encompass many action points, and they embrace many potential agents of change. The key to identifying and seizing the opportunities will be a sense of urgency, an appreciation of the landscape in which action can and must occur, the connections between actions and outcomes and an ability to be bold in ambition and imaginative in partnership.

It is hoped that the findings and recommendations of this report will facilitate the policy convergence work in CFS and will inspire, on the ground, many stakeholders in contributing to progress towards more sustainable food systems that enhance FSN.

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APPENDIX

The HLPE project cycle

The High Level Panel of Experts for Food Security and Nutrition (HLPE) was created in October 2009 as the science–policy interface of the UN Committee on World Food Security (CFS).

The CFS is the foremost inclusive and evidence-based international and intergovernmental platform for food security and nutrition (FSN), for a broad range of committed stakeholders to work together in a coordinated manner and in support of country-led processes towards the elimination of hunger and ensuring FSN for all human beings.[59]

The HLPE receives its working mandate from CFS. This ensures the legitimacy and relevance of the studies undertaken, and their insertion in a concrete political agenda at international level. The report elaboration process ensures the scientific inclusiveness and the independence of the HLPE.

The HLPE produces scientific, policy-oriented reports, including analysis and recommendations, serving as a comprehensive and evidence-based starting point for policy debates at CFS. The HLPE aims at providing a better understanding of the diversity of issues and rationales when dealing with food and nutrition insecurity. It thrives to clarify contradictory information and knowledge, elicit the backgrounds and rationales of controversies, and identify emerging issues.

The HLPE is not mandated to conduct new research. The HLPE draws its studies based on existing research and knowledge produced by various expertise-providing institutions (universities, research institutes, international organizations, etc.), adding value by global, multi-sectoral and multi-disciplinary analysis.

HLPE studies combine scientific knowledge with experiences from the ground, in the same rigorous process. The HLPE translates the richness and variety of forms of expert knowledge from many actors (knowledge of local implementation, knowledge based on global research and knowledge of "best practice") that draw on both local and global sources into policy-related forms of knowledge.

To ensure the scientific legitimacy and credibility of the process, as well as its transparency and openness to all forms of knowledge, the HLPE operates with very specific rules, agreed by the CFS.

The HLPE has a two-tier structure:

1. A Steering Committee composed of 15 internationally recognized experts in a variety of FSN related fields, appointed by the Bureau of CFS. HLPE Steering Committee members participate in their individual capacities, and not as representatives of their respective governments, institutions or organizations.
2. Project Teams acting on a project specific basis, selected and managed by the Steering Committee to analyse/report on specific issues.

The project cycle to elaborate the reports (**Figure 17**) includes clearly defined stages, starting from the political question and request formulated by the CFS. The HLPE institutes a scientific dialogue, building upon the diversity of disciplines, backgrounds, knowledge systems, the diversity of its Steering Committee and Project Teams, and open e-consultations. The topic-bound and time-bound Project Teams work under the Steering Committee's scientific and methodological guidance and oversight.

The HLPE runs two open consultations per report: first, on the scope of the study; second, on a V0 "work-in-progress" draft. This opens the process towards all experts interested as well as to all concerned stakeholders, who are also knowledge-holders. Consultations enable the HLPE to better understand the issues and concerns, and to enrich the knowledge base, including social knowledge, thriving for the integration of diverse scientific perspectives and points of view.

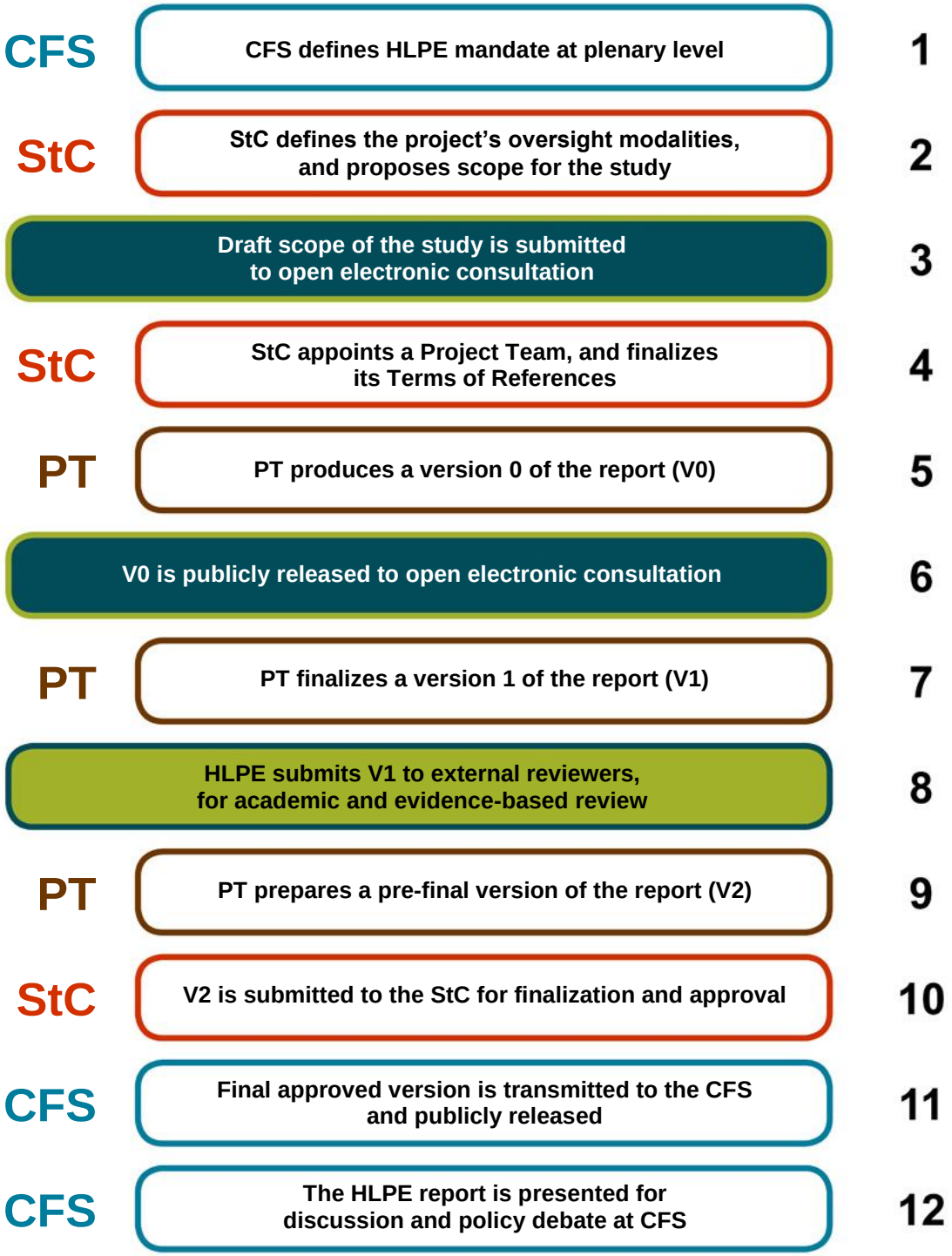
It includes an external scientific peer-review on a pre-final draft. The report is finalized and approved by the Steering Committee during a face-to-face meeting.

HLPE reports are published in the six official languages of the UN (Arabic, Chinese, English, French, Russian and Spanish), and serve to inform discussions and debates in CFS.

All information regarding the HLPE, its process and all former reports are available on the HLPE Website: www.fao.org/cfs/cfs-hlpe

[59] CFS Reform Document, available at www.fao.org/cfs

Figure 17 HLPE project cycle



CFS Committee on World Food Security
HLPE High Level Panel of Experts on Food Security and Nutrition
StC HLPE Steering Committee
PT HLPE Project Team

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Worldwide, one person in three is malnourished today and one in two could be malnourished by 2030 if nothing is done. While hunger remains a critical concern, overweight and obesity are rapidly increasing all over the world, including in low-income countries. Therefore, malnutrition in all its forms – undernutrition, micronutrient deficiencies, overweight and obesity – now affects all countries. Economic growth alone will not be enough to end hunger and malnutrition. Nutrition has to be set as an explicit objective in coherent and cross-sectoral strategies, policies and programmes. In this context, this report analyses how food systems influence people's food choices and nutritional status. It calls for radical transformations and presents effective policies and programmes that have the potential to shape more sustainable food systems, contributing to the progressive realization of the right to adequate food.

CFS COMMITTEE ON WORLD FOOD SECURITY
HLPE High Level Panel of Experts

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