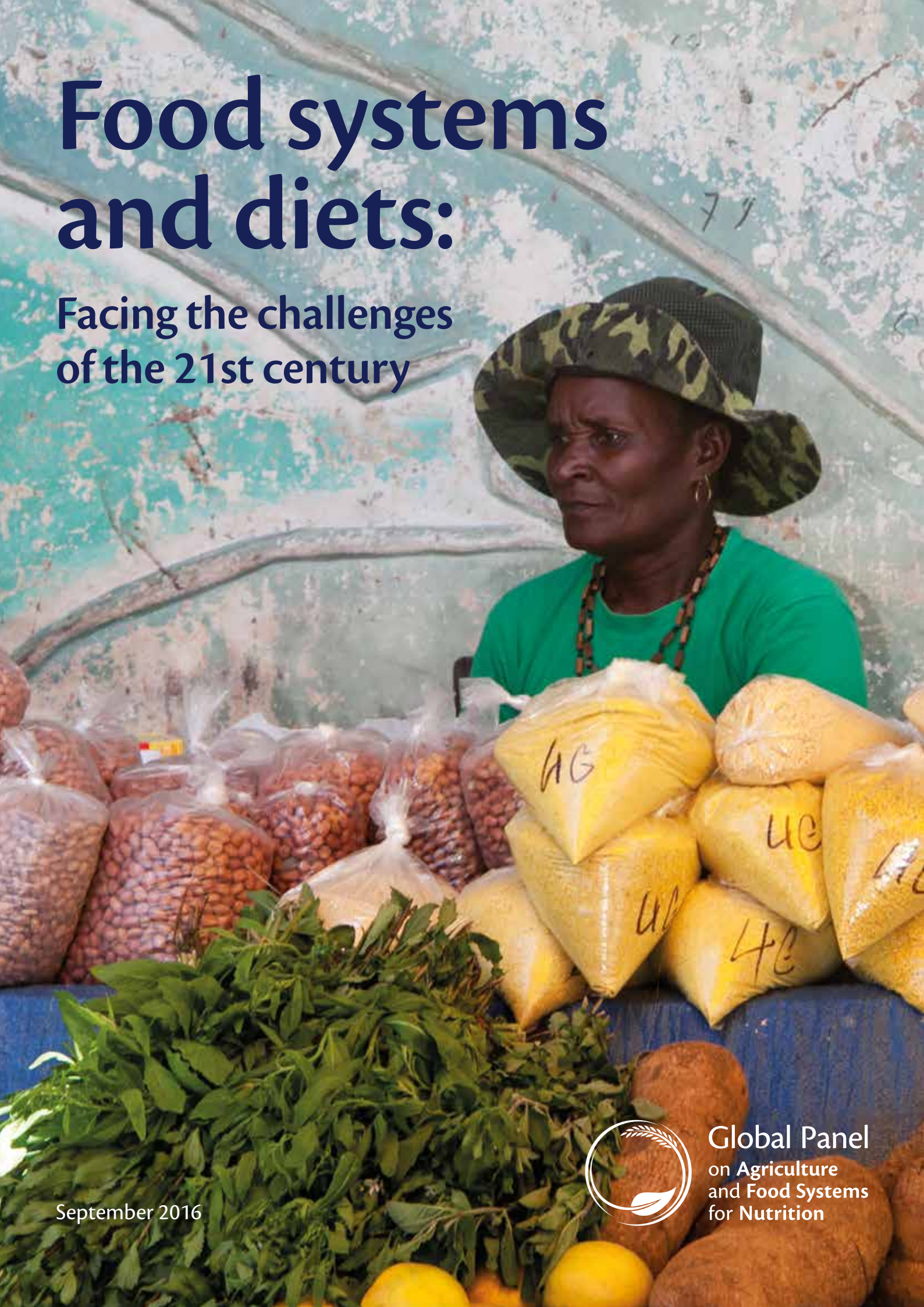
Food systems and diets:

Facing the challenges of the 21st century



September 2016

Global Panel
on **Agriculture**
and **Food Systems**
for **Nutrition**

Food systems and diets:

Facing the challenges of the 21st century

This report includes important recommendations and advice for leaders at the most senior levels in countries and international organizations. It is also of direct relevance to all policy makers, decision makers, professionals, business people, experts and researchers with interests in food systems and diets. Many of these individuals will be directly concerned with the production, processing, trade, regulation, supply and safety of food. However, others may work in wider areas of policy and business, for example relating to: public health and well-being, mental health development, education, economic development, urbanization, globalization and demography.

RECOMMENDED CITATION: Global Panel on Agriculture and Food Systems for Nutrition. 2016. Food systems and diets: Facing the challenges of the 21st century. London, UK.

ISBN 978-0-9956228-0-7

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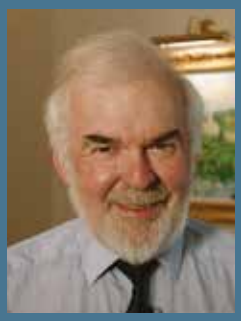

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Preface

The Global Panel on Agriculture and Food Systems for Nutrition commissioned this Foresight report in 2015 to take a close look at the extent to which food systems are delivering healthy diets today and to assess whether they are fit for the future.

While the focus has been on low- and middle-income countries, the findings constitute a stark warning for all countries. Despite past progress, approximately three billion people across the globe now have low-quality diets. Nearly a quarter of all children under five years of age are stunted, more than two billion people have insufficient micronutrients and the incidence of overweight and obesity is growing in every region. As a result, many economies are seriously underperforming, and diet-related chronic diseases are placing ever-greater demands on health care systems. Moreover, the situation is set to worsen dramatically over the next 20 years as powerful drivers of change such as population growth, climate change and urbanization converge on food systems.

This report shows that unless policy makers act decisively to control overweight, obesity and diet-related disease and accelerate efforts to reduce undernutrition, all countries will pay a heavy price in terms of mortality, physical health, mental well-being, economic losses and degradation of the environment. The stark message to world leaders is that only a response on the scale and commitment used to tackle HIV/AIDS and malaria will be sufficient to meet the challenge, particularly in low- and middle-income countries. It is also essential that the public and private sectors work together to achieve this.

This report shows how these considerable challenges can be addressed. In particular, food systems need to be harnessed so that they nourish rather than merely feed people. This alone will open up countless opportunities for interventions that decision makers can tailor to specific situations. The report also sets out clear priorities for action at national and international levels, as well as detailed advice and guidance, which will be of practical and immediate use to decision makers.

On behalf of the Global Panel, we would like to take this opportunity to express our sincere thanks to the Bill & Melinda Gates Foundation, and the UK Department for International Development who together have funded this groundbreaking study. We would also like to thank the group of leading experts, chaired by Professor Lawrence Haddad, who undertook much of the work and drafted this report, the many other experts and policy makers from across the world who contributed, and the team at the Global Panel Secretariat who managed the entire process.

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Foreword

Malnutrition has for too long been a neglected issue. Yet it is a problem that affects one in three people worldwide. Today, 159 million children are stunted, 50 million are wasted and more than two billion people are overweight or obese. But in 2015 for the first time in history, through the Global Goals, the world has committed to ending malnutrition in all its forms. As the 2016 *Global Nutrition Report* makes clear, tackling malnutrition is one of the largest challenges facing all countries. Malnutrition comes in many guises: stunting, wasting, deficiencies of essential vitamins and minerals, and obesity. Reaching the ambitious target of ending malnutrition is only achievable if world leaders can ensure agriculture and food systems policies strengthen nutrition outcomes.

There is a moral imperative to eliminate malnutrition. Undernutrition contributes to 45% of the 16,000 children under the age of five who die every day. The impacts extend well beyond health: stunted children who survive are permanently disadvantaged, perform worse at school and are robbed of future earnings that could support them and their families. But eliminating malnutrition is also an economic imperative. The costs of undernutrition in terms of lost national productivity are significant, with between 3% and 16% of GDP lost annually in Africa and Asia. The good news is that we know that the economic returns from investing in nutrition are high – GBP 16 generated for every pound invested. Boosting nutrition can boost growth.

This Foresight report from the Global Panel on Agriculture and Food Systems for Nutrition on the future of diets provides fresh insights into changes in diets across the world. It highlights the impact of major drivers of change in dietary patterns, including population growth, rising incomes, urbanization and globalization. The report complements the 2016 Global Nutrition Report in delivering strong evidence to underpin policy change. The data presented here focus on the challenges that decision makers face when attempting to integrate nutrition within current food systems and agricultural policies. It sets out ways to approach these challenges so that policies are shaped in a way that delivers healthy, safe and nutritious diets for all.

The Global Panel on Agriculture and Food Systems for Nutrition was first launched by the former UK Secretary of State for International Development at the 2013 Nutrition for Growth Summit. It has proven invaluable for championing the role of agriculture and food systems in preventing malnutrition. The Panel and its work – including this report – are an important contribution to the UK Government's commitment to improve the nutrition of 50 million people by 2020.

Ridding the world of malnutrition will require sustained investment, drive and energy. It will also require innovative solutions that work to tackle both undernutrition and the rising burden of obesity afflicting almost all countries around the world. I urge nutrition and agriculture leaders in governments, business and civil society to act on the Foresight report findings.

James Wharton MP
Parliamentary Under-Secretary of State
Department for International Development

Acknowledgements

The Global Panel on Agriculture and Food Systems for Nutrition would like to thank the Project's Lead Expert Group who oversaw the technical aspects of the Project, who were involved in much of the work and in producing the Project outputs and in drafting this report. They were led by Professor Lawrence Haddad.

The Global Panel is also grateful to the many individuals and organizations from across the world who were involved in the detailed technical work and the Project's advisory bodies – some of these are specifically mentioned below. The Global Panel would also like to thank the Representatives of the Global Panel members, the many other individuals from organizations across the world who contributed views and advice, attended workshops in Africa, Asia and Europe, peer reviewed individual papers, and provided other support.

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Contents

List of abbreviations

AgMIP	Agricultural Model Intercomparison and Improvement Project
ASF	animal source foods
BaU	business as usual
CGIAR	Consortium of International Agriculture Research Centers
CHD	coronary heart disease
DALYs	disability-adjusted life years
FAO	Food and Agriculture Organization of the United Nations
FBDGs	food-based dietary guidelines
FDI	foreign direct investment
GAIN	Global Alliance for Improved Nutrition
GDP	gross domestic product
GNP	gross national product
HDDS	household diet diversity score
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
MAD	minimum acceptable diet
MDD	minimum diet diversity
NCDs	non-communicable diseases
PAHO	Pan American Health Organization
SDGs	Sustainable Development Goals
SSA	sub-Saharan Africa
TFP	total factor productivity
UN	United Nations
WDDS	women's dietary diversity score
WFP	United Nations World Food Programme
WHA	World Health Assembly
WHO	World Health Organization
WTO	World Trade Organization

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Executive summary

The world is facing a nutrition crisis: approximately three billion people from every one of the world's 193 countries have low-quality diets. Over the next 20 years, multiple forms of malnutrition will pose increasingly serious threats to global health. Population growth combined with climate change will place increasing stress on food systems, particularly in Africa and Asia where there will be an additional two billion people by 2050. At the same time, rapidly increasing urbanization, particularly in these two regions, will affect hunger and nutrition in complex ways – both positively and negatively.

Unless policy makers apply the brakes on overweight, obesity and diet-related disease and accelerate efforts to reduce undernutrition, everyone will pay a heavy price: death, disease, economic losses and degradation of the environment. A response, equivalent to that marshalled to tackle HIV/AIDS, malaria and smoking is needed to meet these challenges.

Around the world, coordinated action needs to be accompanied by fundamental shifts in our understanding and in our policy actions. Much more emphasis must be given to positioning agricultural growth as a way to improve diet quality, rather than merely delivering sufficient calories. Food systems need to be repositioned from just supplying food to providing high-quality diets for all. This will require policy initiatives far beyond agriculture to encompass trade, the environment and health, which harness the power of the private sector and empower consumers to demand better diets.

This report is a call to action for world leaders and their governments. Leadership and commitment will be essential in driving forward the decisions set out in this report and in delivering the necessary priority actions to reshape the global food system.

1. KEY FINDINGS

1.1 A growing nutritional crisis

The world has made substantial progress in reducing hunger and undernutrition in the past 25 years. Global rates of hunger have fallen and now affect around one in ten people[1] and the percentage of children who are chronically undernourished has declined to around one in four.[2] Such progress means less suffering, lower mortality rates and improved life chances for hundreds of millions of families and their children.

However, despite these gains, malnutrition in all its forms currently affects one in three people worldwide, far beyond the 795 million who experience hunger on a daily basis. And the situation is rapidly getting worse. Over the next 20 years, multiple forms of malnutrition will pose increasingly serious challenges to policy makers:

- Today, the prevalence rates of overweight, obesity and diet-related chronic diseases such as diabetes[3] and hypertension are increasing in every region and most rapidly in low- and middle-income countries. In sub-Saharan African men, the growth rate of overweight and obesity now exceeds that for underweight. For South Asian women, the prevalence of overweight and obesity is almost the same as the prevalence of underweight. In China, the combined rate of overweight and obese adults is projected to rise to over 50% by 2030.

- Nearly a quarter of all children under five years of age today are stunted, with diminished physical and mental capacities. Less than a third of all young infants in 60 low- and middle-income countries are meeting the minimum dietary diversity standards needed for growth. And undernourished mothers are having babies who will be left with life-long impairments.

- More than two billion people lack vital micronutrients (e.g., iron, zinc, vitamin A) which affects their health and life expectancy. For example, in low- and middle-income countries, over half of the young women and adolescent girls surveyed are not meeting their micronutrient needs. By 2050, the estimated impact of elevated carbon dioxide on the zinc content of grains, tubers and legumes could place 138 million people at new risk of zinc deficiency – with 48 million in India alone.

Looking to the future, if the direction of current policies remains the same, then estimates suggest that by 2030, the number of overweight and obese people will have increased from 1.33 billion in 2005 to 3.28 billion, around one third of the projected global population. This is a major concern as no country to date has successfully reversed growth in obesity once it has been allowed to develop. At the same time, there will still be 653 million calorie-deficient people (down from 795 million in 2015). Most of the reductions in calorie insufficiency will come from Asia, while Africa will see a levelling off. But if nothing is done, Asia and Africa will still be grappling with significant levels of undernutrition in 14 years' time.

Together, these facts offer up a formidable warning to policy makers. Immediate and decisive action is needed to address the challenges that they pose to avert the profound consequences for the health of populations, health care costs and economic growth.

1.2 Malnutrition represents the number one risk factor in the global burden of disease

The impacts of malnutrition are huge. An estimated 45% of deaths under age five are linked to undernutrition and suboptimal breastfeeding alone is responsible for almost 12% of total deaths,[4] mostly in low-income countries. Malnutrition has many causes and a low-quality diet is one of them.

Malnutrition associated with diets that are not nutritious or safe represents the number one risk factor in the global burden of disease. These low-quality diets contain insufficient calories, vitamins and minerals or contain too many calories, saturated fats, salt and sugar. The risk that poor diets pose to mortality and morbidity is now greater than the combined risks of unsafe sex, alcohol, drug and tobacco use (see Fig.1).

Poor nutrition amplifies the health consequences of diseases such as HIV/AIDS, malaria and measles. In economic terms, across Africa and Asia, the estimated impact of undernutrition on gross domestic product (GDP) is 11% every year — more than the annual economic downturn caused by the global financial crisis of 2008–10.[5]

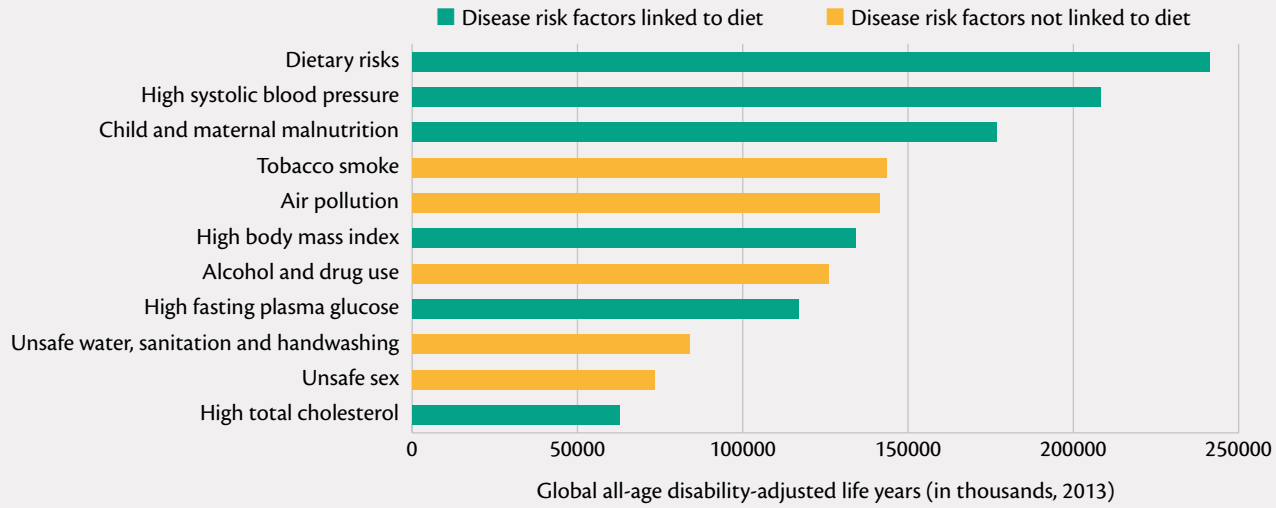
1.3 Food systems are not delivering healthy diets

Today's food systems are too focused on food quantity and not enough on quality. They are not helping consumers to make healthy and affordable food choices consistent with optimal nutrition outcomes. In fact, the trend is in the opposite direction. The multiple forms of malnutrition will not diminish unless policy makers and private sector business leaders work together to reshape food systems in ways that will advance the goal of healthier diets for all.

Over recent decades, agricultural productivity has risen, food trade has increased and the once ever-present threat of famine has receded in most parts of the world. This means many people have better diets than before. But the rate of increase of intake

[1]FAO, IFAD and WFP (2015a) [2]IFPRI (2016a) [3]In this report we refer to "diabetes" to generally mean type 2 diabetes [4]Black et al. (2013) [5]IFPRI (2016a)

FIGURE 1: Six of the top 11 risk factors driving the global burden of disease are related to diet



Source: Global Burden of Disease Study 2013 Collaborators (2015), Figure 5

Note: The graph shows global disability-adjusted life years (DALYs) attributed to level 2 risk factors in 2013 for both sexes combined.

of foods that undermine diet quality has been increasing even faster. For example, in 2000, sales of ultra-processed foods and beverages in the upper-middle-income countries were one-third of those in the high-income countries. Fifteen years later, they were more than half. So while there have been dietary improvements, the net result is still low-quality diets.

As this report shows, rising incomes alone will not improve the quality of people's diets. As incomes increase, food scarcity diminishes but the cost of many nutritious foods remains high and the ability to purchase foods that do not support high-quality diets increases. Currently, income growth is a double-edged sword when it comes to improving diets.

Box 1: What is a high-quality diet?

While there is no universal 'diet quality index', there is general agreement on what a healthy or high-quality diet should include, i.e. a diversity of foods that are safe and provide levels of energy appropriate to age, sex, disease status and physical activity as well as essential micronutrients. The World Health Organization's (WHO) definition of a healthy diet emphasizes the importance of starting healthy eating habits in early life (notably through breastfeeding) and limiting the intake of free sugars and salt. It advises people to eat plenty of fruits and vegetables, wholegrains, fibre, nuts and seeds, while limiting free sugars, sugary snacks and beverages, processed meats and salt, and replacing saturated and industrial trans fats with unsaturated fats.

1.4 The importance of a food system approach

Policy makers need to ensure that all parts of food systems work together to deliver high-quality diets (see Box 1). This means thinking well beyond agriculture to also consider the many processes and activities involved in food production, processing, storage, transportation, trade, transformation and retailing. This amounts to a change in mindset, and a fundamental shift in approach. Whatever progress is made towards food security, unless foods reach people in a form that is nutritious and affordable, the problem of poor-quality diets will not be solved.

Food systems are changing rapidly with important consequences for changing diets. The food chains that supply consumers are growing longer, with global trade increasing the distance between production and consumption, as well as the diversity of foods available to consumers. Value and power in food systems is shifting towards the middle of these food chains, with agricultural produce becoming ingredients for processed products. Decisions by large agri-businesses, manufacturers and retailers are playing a growing role, relative to the public sector, in the availability, affordability, safety and desirability of foods. Policy makers need to ensure that food system changes like these contribute to, and do not detract from, high-quality diets.

The bottom line is that food systems are failing us. Those who would benefit from consuming more animal source foods, fruits, vegetables and pulses often find them unaffordable. Others who need to reduce their consumption of red meat may be unable to switch to other sources of flesh-based food such as fish.

In the longer term, food systems will be subject to major stresses resulting from important external influences (see Box 2). Population growth, climate change, and increased competition for natural resources are notable examples. But others such as income growth, urbanization and globalization of diets are likely to have mixed effects – with both positive and negative consequences for diets. It is essential that policy makers think through the consequences of all of these drivers of change for their own food systems.

The good news is that there are many ways in which policy makers can reshape food systems. Extending policy action beyond agriculture to the entire food system opens up many opportunities to improve the consumer's ability to access food that is safe, nutritious and affordable. The full Foresight report provides detailed guidance on the many options available to policy makers to allow them to act now on their own food systems, to help address diet-quality-driven malnutrition crises in their countries.

Box 2: Long-term drivers of the nutrition crisis

Food system policies must be developed which are resilient to future long-term threats and uncertainties – examples of these are listed below. Action is needed now since some policies and initiatives may take many years or decades to take full effect, e.g. restructuring food systems, investing in infrastructure and influencing consumer attitudes.

Changes in the size and age distribution of populations
Population growth rates are decelerating as declining birth rates catch up with declining mortality rates. But global food systems will need to provide high-quality diets to more than two billion additional people by 2050. Over a billion will be in Africa. A particular effort is needed to improve diets of infants and young children to support their cognitive development and to enable them to capitalize on work opportunities. A focus on improving the nutrition of adolescent girls and women of child-bearing age will also be required.

Climate change
By 2050, there could be over half a million net additional deaths from diet-related causes compared to a scenario with no climate change – most would occur in low- and middle-income countries. Both direct and indirect effects (e.g. due to a rise in energy costs) need to be considered when developing climate-smart policies.

Rapid urbanization
Urban populations are growing most rapidly in Africa and Asia. Urban dwelling is associated with less undernutrition than rural populations but more diet-related obesity and chronic disease, and greater risks from food price volatility. While the urban poor experience low-quality diets and food safety risks, they have potentially good access to fresh produce and products fortified with micronutrients. The challenge is to find ways of strengthening the positive links between urbanization and diet quality while maintaining its ability to help reduce hunger and undernutrition

Income growth
Countries cannot expect to 'grow' their way out of poor diet quality and address the multiple forms of malnutrition. While income growth among low-income consumers will help to reduce undernutrition, it will also create substantial new problems relating to overweight and obesity and associated non-communicable diseases (NCDs).

Globalization of diets
Diets, even in the poorest countries, are increasingly affected by the growing global nature of food trade and trade-related industries. Globalization can act to increase resilience by allowing deficits in one region to be met by others but it can also decrease resilience by propagating systemic shocks. But globalization may also have helped to drive the obesity epidemic by making it easier for consumers to make low-quality diet choices.

Competition for natural resources
This will increasingly constrain food production, but could also stimulate technical progress. Overall, it could drive diets in unpredictable and highly context-specific ways. The growing consensus on the need to price scarce resources, such as water and carbon storage, should provide strong incentives both to increase efficiency of resource use and generate technical improvements.

In economic terms across Africa and Asia, the estimated impact of undernutrition on gross domestic product (GDP) is 11% every year.

2. A CALL TO ACTION

2.1 Nutrition – a new global priority

Agriculture and food systems must deliver much more than food – they need to fulfil their potential to underpin the health and well-being of populations. At a fundamental level, consumers are making food choices that are not consistent with good nutrition, health and well-being. And public policies or private sector actions are not adequately aligning food systems toward the goal of improving nutrition.

However, the long path that high-income countries have taken to try and manage rising obesity rates has not succeeded. That same path is not an inevitable one for low- and middle-income countries. There are alternatives, provided the right choices are made now and throughout the food system. The challenge for policy makers in low- and middle-income countries is to find more direct and less damaging dietary pathways from where their diets are today, to where they need and want to be. South Korea is a good example of a country that has gone from low- to middle- to high-income levels in the past 30 years in a way that has supported the supply of relatively accessible and affordable high-quality diets. It is no coincidence that this country has implemented many food system policies that aim to promote health.

At a global level, stakeholders need to prioritize the improvement of nutrition – and the consumption of the healthy diets that promote it. While the Sustainable Development Goals have put ending hunger, achieving food security, improving nutrition and promoting sustainable agriculture high on the global agenda, the 2016–2025 UN Decade of Action on Nutrition provides many potential opportunities to place the improvement of diet quality through food systems at the centre of global action.

The international community needs to step up and accord the goal of healthy diets to all, and extend the same level of focus and commitment that it gave to addressing HIV/AIDS, malaria and smoking. This will require stakeholders from governments, civil society, the media, business and research to work together to make improving dietary quality a sustained political priority.

At the national level, governments and private sector actors need to work together to focus on aligning individual food systems with the goal of attaining healthy diets and improved nutritional outcomes. This will require, amongst other actions, creating incentives for private sector actors throughout the food system so that they can make decisions more favourable to the adoption of higher-quality diets.

It will be critical for governments to look across both food system objectives and broader goals and constraints including the need to build sustainability into the country's agricultural system, conserving limited water supplies and promoting long-term management of soils, forests and biodiversity. In particular,

FIGURE 2: Six steps to identify policy actions to achieve healthy diets

careful consideration needs to be given to the relationships between diets that are high-quality from a nutritional perspective, and their potential impacts on the environment. These are more complex than popularly assumed and are likely to differ considerably in different contexts.

Effective evidence-based policy making should be supported by the use of appropriate analytical tools. Figure 2 sets out six sequential steps that policy makers need to work through. The full report provides detailed guidance for each step, together with advice concerning promising policy actions to improve diets. These relate to the various parts of the food system, from production to storage, transport, trade, transformation and retailing.

2.2 Specific priorities for action

Policy makers and other key decision makers need to work throughout the food system to effect diet change.

While most actions will depend heavily on local contexts, the following are universally applicable:

1. **Focus food and agriculture policies on securing diet quality for infants and young children.** These are woefully inadequate in many countries. Improved policy choices are needed which recognize the centrality of high-quality diets for the youngest.

2. **Improve adolescent girls and adult women's diet quality as a priority in all policy making that shapes food systems.** Women are particularly vulnerable to the health impacts of low-quality diets because of their higher nutrition requirements and because of their disempowerment in some cultures.

3. **Ensure that food-based dietary guidelines (FBDGs) guide policy decisions to reshape food systems.** FBDGs are largely absent in low-income countries (present only in 2 out of 31) and limited in lower-middle-income countries (12 out of 51). They are needed to inform and to influence food policies around the world.

4. **Animal source foods (ASF) (e.g. dairy, eggs, fish and meat) provide important nutrients. Policy support for these foods should be pragmatically evidence-based rather than driven by ideology.** Infants, children, adolescents and women of reproductive age living in low-income contexts will find it extremely hard to meet nutrient requirements in the absence of these foods. At the same time, some groups in low-income contexts are consuming levels of these foods in excess of recommended levels.

5. **Make fruits, vegetables, pulses, nuts and seeds much more available, more affordable and safe for all consumers.** They offer considerable benefits in terms of diet quality. There are opportunities throughout the food system to overcome supply-side barriers to make them available, affordable and appealing. Public policy can also incentivize greater investment in the infrastructure required to produce, store and transport these foods.

6. **Make policies which regulate product formulation, labelling, advertising, promotion and taxes a high priority.** These are needed to create disincentives for companies to allocate resources to forms of processing that undermine diet quality. Policies to educate consumers of the adverse health effects of consuming these products more than occasionally, are also needed.

7. **Improve accountability at all levels.** Governments committed to reshaping food systems toward healthy diets need to set targets and publish transparent scorecards of their results. Private sector actors should acknowledge their far-reaching roles in defining food environments – and the nutritional quality of foods and other products that they promote to consumers. Civil society organizations need to monitor the performance of others.

8. **Break down barriers associated with the longstanding division of jurisdictional responsibilities within many governments – between agriculture, health, social protection and commerce.** These can fundamentally impede integrated action across food systems, inhibit the effective allocation of resources and create barriers that inhibit access to data.

9. **Institutionalize high-quality diets through public sector purchasing power.** Food provided in schools, hospitals, across the armed forces and in the prison system should be of the highest dietary benefit to the consumer. This approach has the potential to shape the norms around foods that contribute to high-quality diets and incentivize suppliers and contractors to align their value chains accordingly.

10. **Refocus agriculture research investments globally to support healthy diets and good nutrition** (see Box 3). Global and national public research organizations (and their funders) must rebalance their priorities to reflect a priority focus on high-quality diets. **Much more investment in research on fruits and vegetables, animal source foods, legumes, nuts and seeds is urgently required.** Better national-level and subnational data are needed on diet, consumer food prices, food safety, food loss and waste. The Access to Nutrition Index that assesses the conduct and performance of companies should be strengthened at the country level.

Box 3: Research priorities

Research on food, agriculture and nutrition must be refocused on achievement of healthy diets
The international and national agricultural research communities should play a strong leadership role in promoting research that addresses productivity, profitability, sustainability and nutritional goals at the same time. A 'high-quality diet' lens must guide a rebalancing of funding allocations across the food system.

Metrics for diet quality and the food system need to be modernized
They are also needed to enable policy makers to monitor the implications of dietary choices for the future of the environment.

More and better data
Effort is urgently needed to substantially improve the quantity and quality of dietary data. Few national governments collect the data required to inform decision makers about what people actually eat and the UN has no functioning global dietary database. Recent efforts to gather data such as the Global Dietary Database (GDD) and FAO/WHO GIFT (FAO/WHO Global Individual Food Consumption data Tool), being developed by the Food and Agriculture Organization of the United Nations (FAO) and the World Health Organization (WHO), should be built upon.

Many other indicators for the food system also need to be collected, for example on food quality and safety to help policy makers understand the links between food systems and actual nutritional outcomes.

More and better evaluation
Policy makers need to be able to assess the effect that specific interventions and policy actions have on diet quality and to determine how they could be improved. For example, recent work to track changes in the purchases of sugar-sweetened beverages in Mexico following imposition of a new tax, sheds important light on consumer choices in a changing food environment.

This report highlights the very serious challenges facing policy makers today and in the future. Already, approximately three billion people on the planet – from every country – have low-quality diets.

But this report also shows that current trends do not have to persist if the right actions are taken now and in the coming decades. Better diets are possible. Ensuring that all people eat healthily is a moral and economic imperative. This will require focused, determined and sustained action from policy makers working in partnership with the private sector in complex and rapidly changing environments. With so much at stake, we all share a responsibility to find solutions that work for everyone. There are many public policy opportunities to act on in the food system beyond agriculture to improve the consumer's ability to access food that is safe, nutritious and affordable.

This report shows that current trends do not have to persist if the right actions are taken now and in the coming decades. Better diets are possible.

1 The central role of high-quality diets and food systems in ending malnutrition in all its forms

KEY MESSAGES

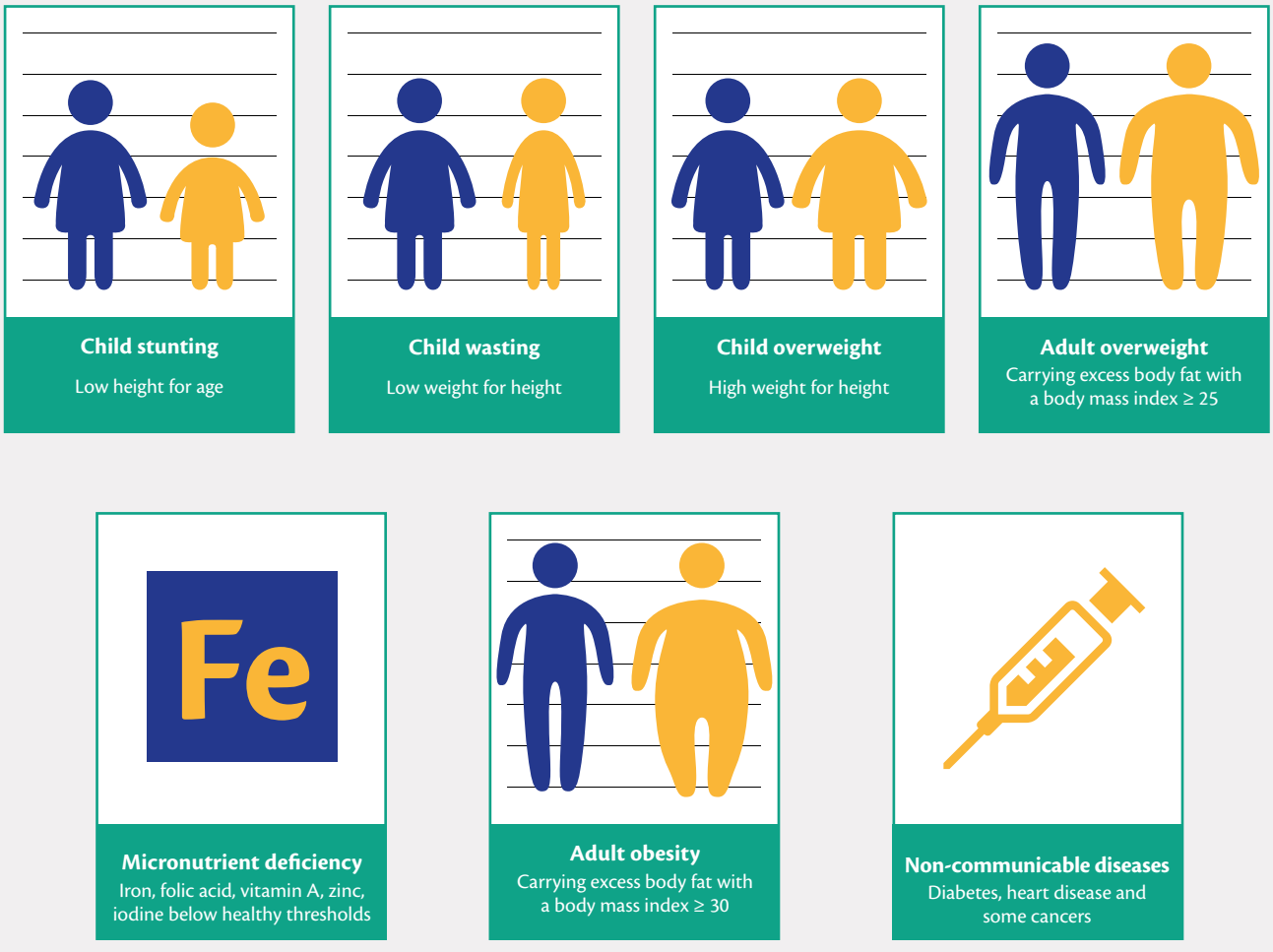
- **Despite progress, much of the world does not eat high-quality diets – of all risk factors, diet is responsible for the largest burden of global ill health and needs immediate and urgent attention by policy makers.**
- **Many countries are experiencing a "double burden" of both undernutrition and overweight:**
  - **An estimated 45% of deaths of children under five are linked to malnutrition and the economic consequences of undernutrition represent losses of gross domestic product of 10%, year in and year out.**
  - **Adult obesity rates are increasing in all 193 countries – if current trends continue, the combined number of overweight and obese adults will increase from 1.33 billion in 2005 to 3.28 billion in 2030.**
- **Food systems are key to improving diets, but are under increasing pressure due to diverse factors such as population growth, urbanization and the uncertainties induced by climate change.**
- **This report provides clear and practical advice on how policy makers in all countries can address the challenges facing their populations – by changing how we think about food systems and diet quality, and through the many possible interventions in food systems.**

1 The central role of high-quality diets and food systems in ending malnutrition in all its forms

This report addresses the question: "What decisions do policy makers need to take in the coming decade to ensure that food systems deliver high-quality diets to people in low- and middle-income countries by 2035?" By high-quality diets, we mean diets that eliminate hunger, are safe, reduce all forms of malnutrition and promote health. High-quality diets are adequate, diverse and balanced. It is important that high-quality diets are produced without undermining the environmental basis for generating high-quality diets for future generations.

Diet quality matters because low-quality diets are linked to a range of malnutrition and health outcomes, including: stunting, wasting, micronutrient deficiencies, overweight and obesity, diet-related, chronic, non-communicable diseases (NCDs), high blood pressure and high cholesterol (Figure 1.1). These forms of malnutrition that are associated with inadequacy on the one hand and excess on the other, collectively characterize the "double burden" of malnutrition around the world. While low-quality diets are just one cause of this double burden, they are an important one.

FIGURE 1.1: Different forms of malnutrition



Source: 2016 Global Nutrition Report (IFPRI, 2016a)

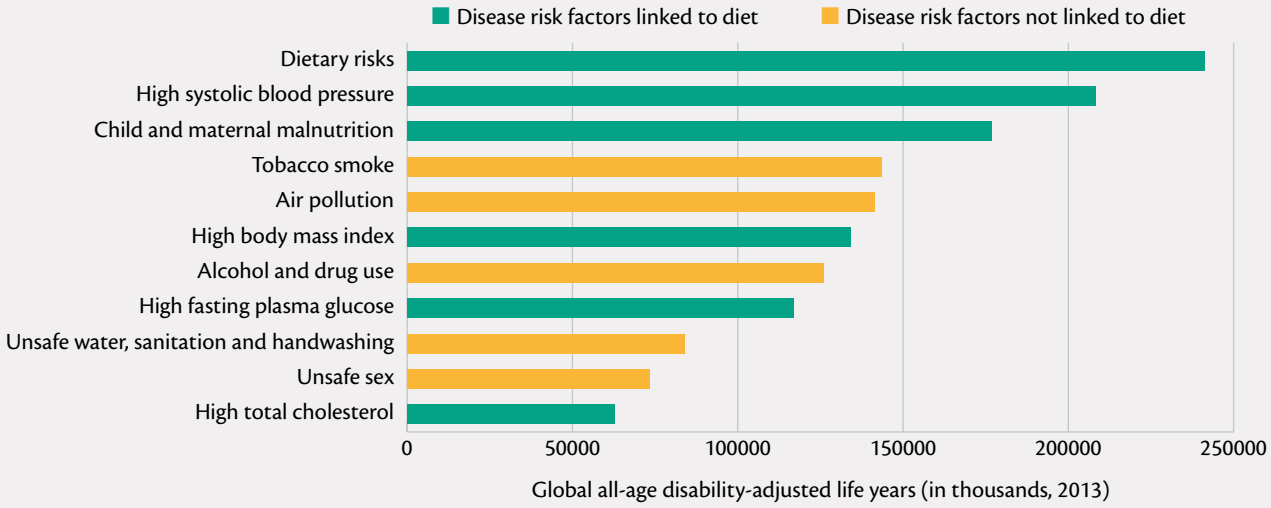
1.1 The problem of malnutrition and low-quality diets

The world has made substantial progress in reducing hunger and undernutrition in the past 25 years. Global rates of hunger have declined from 18.6% in 1990 to 11.8% in 2012[6] and the percentage of children who are stunted has fallen from 39.6% to 23.8%. [7] This progress means less suffering, lower mortality rates and improved life chances for hundreds of millions of families and their children. For these people, improvements in the quantity and quality of diets have played a key role in these achievements, along with a wide range of additional factors such as poverty reduction, improvements in agricultural productivity and expanded access to improved basic education, clean water and sanitation, health care and effective nutrition interventions.[8] There have also been declines in mortality from heart disease in high-income countries, with some positive trends in some low- and middle-income countries, although the picture is very mixed.[9]

But, as this report will show, diet quality is an area that requires far greater attention. For example, in the 60 low- and middle-income countries for which recent data exist, only about a third of all young infants are meeting minimum standards for diet diversity. In six sub-Saharan countries, more than half of all women surveyed did not consume any legumes, nuts, vitamin A-rich fruits and vegetables, dairy or eggs in the day before the survey.[10] For adults, obesity rates are increasing in all 193 countries.[11]

New data from the 2015 Global Burden of Disease study[12] show that much of the world does not eat high-quality diets[13] and that diet, of all risk factors, is responsible for the largest burden of global ill health (Figure 1.2). And this is an underestimate. As the study notes: "If one were to quantify the contribution of diet mediated through weight gain and body mass index (BMI), the overall effect of diet would be much larger than is estimated here." A similar argument could be made for the contribution of poor diets to child and maternal malnutrition and all the other risk factors (highlighted in green) in Figure 1.2. Diet is an important factor in every region. For example, the 2015 Global Burden of Disease study shows that six of the top 11 risk factors are diet related.

FIGURE 1.2: Six of the top 11 risk factors driving the global burden of disease are related to diet



Source: Global Burden of Disease Study 2013 Collaborators (2015), Figure 5

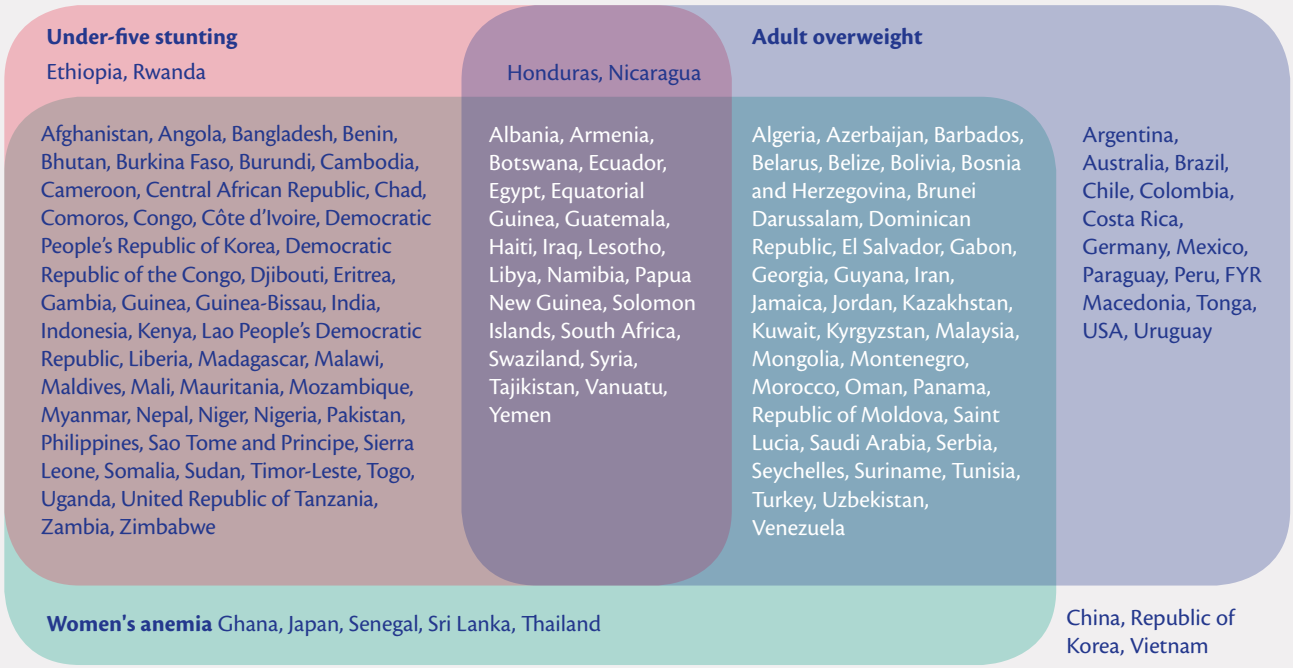
Note: The graph shows global disability-adjusted life years (DALYs) attributed to level 2 risk factors in 2013 for both sexes combined.

In Nigeria, the number of adults with type 2 diabetes is estimated to double between 2011 and 2030: from 3.1 million to 6.1 million.

In Ethiopia, the corresponding numbers will also double: from 1.4 million to 2.7 million.

[6]FAO, IFAD and WFP (2015a) [7]IFPRI (2016a) [8]See for example: O'Donnell, Nicolás and Doorslaer (2009); Monteiro et al. (2009); Headey et al. (2015); Headey and Hoddinott (2014); Haddad et al. (2014); IFPRI (2015b); IFPRI (2015c). [9]Critchley et al. (2016) [10]See Chapter 3 for details. [11]IFPRI (2016a) [12]Global Burden of Disease Study 2013 Collaborators (2015) [13]Global Burden of Disease Study 2013 Collaborators (2015)

FIGURE 1.3: The multiple burdens of malnutrition faced by countries[19]



Source: 2016 Global Nutrition Report, Table A1.1 (IFPRI, 2016a)

Low-quality diets contribute to three very troubling nutrition trends.

- First, undernutrition and hunger are declining very slowly in some regions. In sub-Saharan Africa, the number of stunted children is 58 million and is rising by 500,000 every year and while the total is decreasing in Asia, the numbers remain very high at 91 million.[14] Undernutrition contributes to a high mortality burden. The joint effects of foetal growth restriction, suboptimal breastfeeding, stunting, wasting and vitamin A and zinc deficiencies for children under five, result in 45.4% of all deaths worldwide in this age group. Suboptimal breastfeeding alone is responsible for 11.6% of total deaths.[15]

- Second, rates of overweight, obesity and diet-related non-communicable diseases such as diabetes are increasing in all regions and most rapidly in low- and middle-income countries. For example, for sub-Saharan African men, the growth rate of overweight and obesity now exceeds that for underweight. For South Asian women, the prevalence of overweight and obesity is almost the same as the prevalence of underweight.[16] Projections of these indicators suggest the situation is going to get much worse by 2030 (Box 1.1).

- Third, many countries (57 of the 129 for which data are available) experience significant levels of both undernutrition and overweight (labelled in white in Figure 1.3). When malnutrition is considered in all its forms, it is responsible for serious public health problems in nearly every country on earth, directly affecting one in three people.

Box 1.1: Projections for overweight, obesity and diabetes to 2030

- Globally, if current trends continue, the combined number of overweight and obese adults will increase from 1.33 billion in 2005 to 3.28 billion in 2030.[17]
- In China, the combined rate of overweight and obese adults has risen from 14.6% in 1992 to 32.3% in 2012 and is projected to increase to 51.2% by 2030.[18]
- In Nigeria, the number of adults with diabetes is estimated to double between 2011 and 2030: from 3.1 million to 6.1 million. In Ethiopia, the corresponding numbers will also nearly double: from 1.4 million to 2.7 million.[19]
- By 2030, Bangladesh will have more adults with diabetes than Mexico or Indonesia.[21]

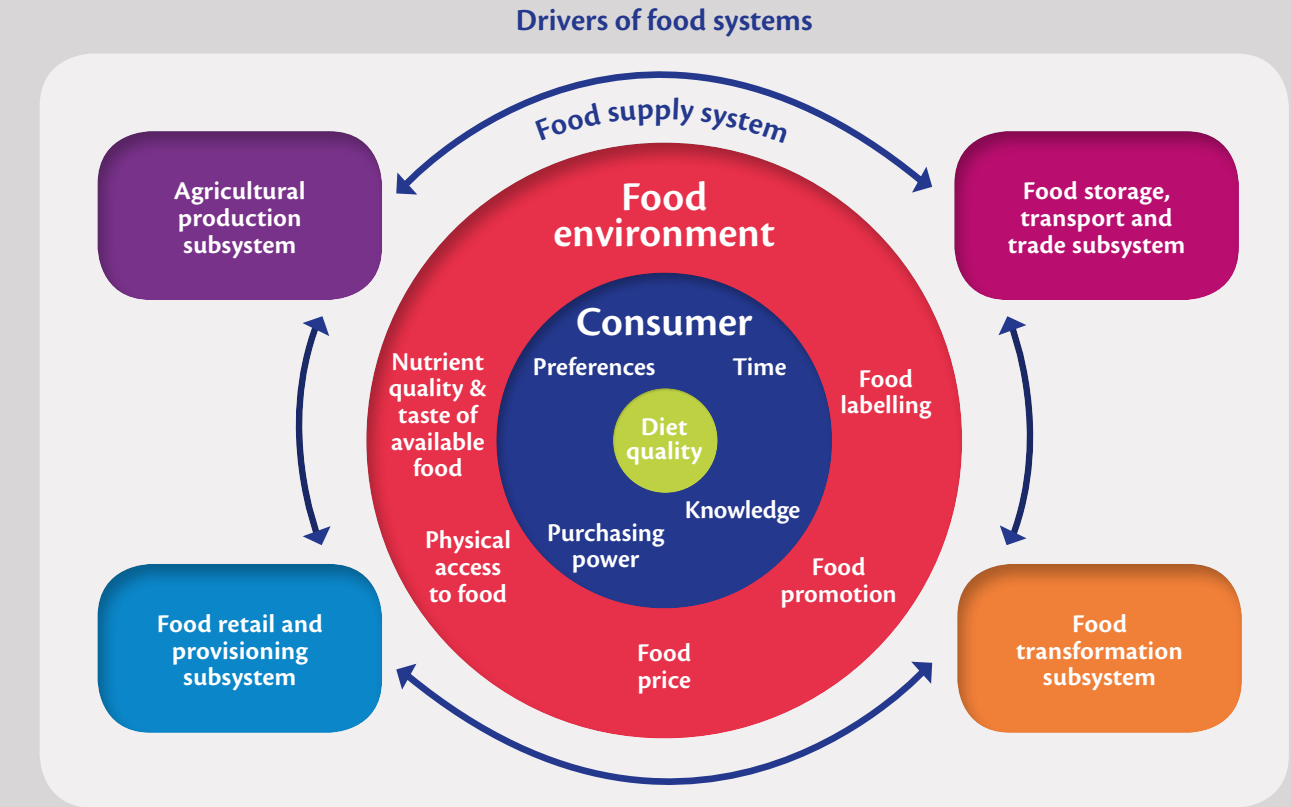
[14]IFPRI (2016a) [15]Black et al. (2013) [16]NCD-RisC (2016) [17]Kelly et al. (2008) [18]Zhu et al. (2016) [19]Whiting et al. (2011) [20]Whiting et al. (2011)
[21]The cut-offs for placing countries in each indicator category are as follows: Under-age-five stunting ≥ 20%, women of reproductive age anaemia ≥ 20% and adult overweight ≥ 35%. These cut-offs were selected because they are considered to indicate public health significance by the World Health Organization (WHO, 2010). Full results appear in Appendix Table A1.1 of the Global Nutrition Report 2016.

These trends are troubling because they are damaging and once established, difficult to reverse. The various manifestations of malnutrition have profound impacts on lives and livelihoods throughout people's lifetimes and from generation to generation. Undernourished children are less likely to survive to see their fifth birthday, less likely to stay in school, less likely to escape poverty as adults and are more vulnerable to the onset of chronic and non-communicable diseases later in life. If they are females, they are more likely to give birth to malnourished babies. Estimates of these effects are striking. As previously mentioned, an estimated 45% of deaths of children under five are linked to malnutrition.[22] The economic consequences of undernutrition represent losses of gross domestic product (GDP), year in and year out, of 10% – far greater than the annual percentage loss in world GDP due to the global financial crisis in the period 2008–10.[23] Estimates of the economic consequences of nutrition-related, non-communicable diseases (NCDs) are also large. In China, for example, people diagnosed with diabetes face an annual 16.3% loss of income.[24] The consumption of high-quality diets is central to reversing these three very troubling trends.

1.2 The role of food systems

This report focuses on the key role of food systems in improving diet quality. As Figure 1.4 shows, diet quality is influenced by consumer purchasing power. But the way income is expended is in turn influenced by 'food environments', which provide the options from which people make decisions about what to eat, circumscribe how income can be spent on food and contribute to shaping people's food preferences, attitudes and beliefs and food cultures more broadly.[25] Food environments are in turn influenced by broader food systems, which themselves are affected by many drivers of change. Food systems present many opportunities – many hardly yet tried – to improve diets. The potential is enormous and provides much cause for optimism.

FIGURE 1.4: Conceptual framework for the links between diet quality and food systems



Source: Compiled by the authors

[22]Black et al. (2013) [23]Horton and Steckel (2013); IFPRI (2015a); United Nations (2016b) [24]Liu and Zhu (2014) [25]Herforth and Ahmed (2015); Hawkes et al. (2015)

However, increasing pressures from population growth, rapid urbanization and the uncertainties induced by climate change all present challenges and opportunities for food systems. Policy makers already have a key role in addressing these pressures on food systems. In addition, policy plays an important part in shaping the incentives that influence food systems and therefore diet quality. In light of the burden of malnutrition and ill health described above, this report focuses on realigning food system policies so that they encourage and enable higher-quality diets.

The demand from policy makers for more guidance in this complex area has been steadily increasing. An extensive array of reports has been published on food systems and nutrition in the past two to three years (see Appendix 1, Table 1.1). These important reports have covered four aspects of food systems: (1) metrics for food system outcomes;[26] (2) approaches to analysing food systems;[27] (3) opportunities and policies for making existing policies along food value chain more nutrition-sensitive;[28] and (4) more in-depth reviews of important topics within the food system space (e.g. food loss and waste).[29]

Recent international commitments on nutrition are also focused on food systems. The outcome documents of the Second International Conference on Nutrition in 2014 called for "strengthening sustainable food systems"[30] and the new United Nations Decade of Action on Nutrition 2016–25 supports the strengthening of food systems for improved nutrition.[31] To implement the Sustainable Development Goals (SDGs), the United Nations Zero Hunger Challenge is driving forward a new approach 'Transforming our Food Systems to Transform our World' on the basis that:

> *"Achieving the Sustainable Development Goals cannot happen without ending hunger and malnutrition and without having sustainable and resilient, climate-compatible agriculture and food systems that deliver for people and planet."*[32]

This report aims to build on existing work by identifying the role that food systems can play in improving diet quality and providing guidance to policy makers to implement international commitments on improving food systems for nutrition. It is directed at government policy makers in low- and middle-income countries but will also be relevant to those in high-income countries. Low- and middle-income countries are most likely to be experiencing multiple burdens of malnutrition and policy makers need an approach that can guide them to the policies that are likely to have the greatest impact on diet quality and nutrition. In high-income countries, the malnutrition problems – typically obesity-related – are less varied. This report is relevant to their policy makers, as it will help address the issues their own populations face, and because they often play a powerful role in the governance of food systems, with consequences for all countries.

Food systems need to be repositioned: from feeding people to nourishing people well.

We also aim to provide guidance to decision makers in the private sector, although fewer explicit recommendations are directed at them. We take this position primarily because the private sector stakeholders consulted during the course of preparing the report indicated that if governments set the incentives, they would make the decisions within those parameters that maximize commercial outcomes.

The report starts by asking the question often posed at the outset by those with a stake in improving diet quality: What is a high-quality diet? While we have defined a high-quality diet generically as a diet that eliminates hunger, is safe, reduces all forms of malnutrition and promotes health, there is a need for a more specific understanding of the different types of foods and the level of intake of those foods that make up a high-quality diet. The composition of a high-quality diet will vary from place to place depending on availability and culture. However, there is already much guidance at the national and international levels on the foods that contribute to a high-quality diet. We can therefore answer the question by bringing together what international and national bodies already recommend as high-quality diets.

A subsequent question is: What are the people in different countries, regions or localities actually eating? We find the question worryingly difficult to answer on the basis of existing data. Nevertheless, based on an extensive scoping exercise in Chapter 3, the best available food intake and sales data are used to provide a picture of recent general trends in diet quality in different regions of the world. In Chapter 4, we review existing forecasts of how diets are likely to change in the future and show the consequences for health outcomes under a series of assumptions about the future availability of food. In Chapter 5, we consider the underlying drivers of these trends, such as income growth, urbanization and climate change.

Then we move to the central question of this report: How can food systems be leveraged to improve diet quality? In Chapter 6, we explain what food systems are and identify elements that could be strengthened to improve diet quality. We break the food system down into the food supply system (consisting of five subsystems), food environments and consumers (Figure 1.4). Chapter 7 outlines some of the options available to policy makers to lever food systems towards better quality diets. It divides policies into three categories: improving delivery of actions already tried with the

[26]Fanzo, Cogill and Mattei (2012); Acharya et al. (2014) [27]Global Panel (2014); IPES-Food (2015); IOM and NRC (2015)
[28]FAO (2013); Bereuter and Glickman (2015); Townsend (2015); IFPRI (2016b) [29]HLPE (2014) [30]FAO (2016c) [31]FAO (2016d) [32]United Nations (2015)

goal of improving diet quality; levering existing food systems policies towards diet quality; and ideas for novel actions.

Chapter 8 calls for change in how we think about food systems and diet quality. First, there is a need to recognize that countries cannot simply grow their way out of these problems. Certainly, economic growth is helpful in reducing undernutrition but for obesity and diabetes, income growth is part of the problem as well as part of the solution. Second, policy makers in low- and middle-income countries need to know that their countries do not have to follow the long and damaging path that high-income countries are taking towards high-quality diets – there are shorter routes available. Finally, it is important for all policy makers to recognize that while food systems function primarily to produce food and income, they are also intrinsically linked to health. If they are not explicitly designed to improve health, there are few guarantees that they will do so.

Low- and middle-income countries need to know that they do not have to follow the long and damaging path that high-income countries are taking towards high-quality diets.

Ultimately this report is intended to help policy makers align food systems to make it easier for consumers to make decisions that favour high-quality diets. Thus, the aims of the report are two-fold. First, to change the way decision makers think about the diet quality problem and its solutions: that food systems are not just production systems but nutrition and health systems and provide many of the solutions; that low- and middle-income countries do not have to follow the circuitous path of high-income countries to get higher-quality diets; and that income growth on its own cannot be relied upon to prevent countries falling into a multiple burden trap for malnutrition.

The second aim is to help decision makers identify and design policy solutions for the diet and nutrition contexts in which they work and provide them with evidence-based arguments to make the case for implementing them. Failure to take decisive actions now will lead to very serious health and economic impacts for all in society, but especially for women, infants and young children, impacts that will that will reverberate throughout the life cycle and across generations.

2 What is a high-quality diet?

KEY MESSAGES

- **Diet quality indicators for groups vulnerable to undernutrition, national food-based dietary guidelines, World Health Organization (WHO) guidance for a healthy diet and knowledge of unsafe food, all provide a good indication of what constitutes a high-quality diet.**
- **These recommendations stress the importance of eating a diverse diet made up of safe foods, drawing on as many food groups as possible, with plenty of fruits and vegetables, wholegrains, fibre and nuts and seeds, while limiting free sugars, sugary snacks and beverages, processed meats and salt, and replacing saturated and industrial trans fats with unsaturated fats.**
- **More countries need up-to-date, food-based dietary guidelines to help provide guidance to design policies to improve diet quality.**
- **So that high-quality diets can be delivered to people in the future, they must be produced sustainably.**

2 What is a high-quality diet?

In this chapter, we establish what governments and international agencies recommend people should eat to achieve a high-quality diet. The chapter also considers the environmental trade-offs involved in eating certain diets and foods.

2.1 Defining a high-quality diet

High-quality diets are those that eliminate hunger, are safe, reduce all forms of malnutrition, promote health and are produced sustainably i.e. without undermining the environmental basis to generate high-quality diets for future generations.

What is a high-quality diet? This is a difficult question to answer in a definitive sense for all countries. There are four core reasons for this:

- While there is a fair amount of agreement on what a high-quality diet should deliver in terms of nutrients and diet components for all individuals, translating this into diets that are affordable and culturally acceptable varies between contexts.
- People of different age, gender, disease status and physical activity patterns have different dietary needs for energy[33] and for micronutrients.[34]
- Diet quality already varies widely between and within countries, which in some cases means different recommendations will be required. For example, in some countries where the intake of micronutrients is very low for certain vulnerable groups, the advice could be to increase the intake of meat because it is a good source of these micronutrients. However, in countries where meat consumption is so high that it presents a disease risk, the advice could be to consume less meat.
- There is as yet no universally agreed set of indicators to measure diet quality.[35]

Despite these challenges, there is a range of existing international and national sources, which can be used to characterize what is already recommended for high-quality diets. The first is from the food security and undernutrition literature and emphasizes the special requirements of babies, infants and young children and the need to diversify diets, especially in low-income settings. The second derives from the literature on human diseases, which assumes that calorie requirements have been met and focuses on energy balance and the consumption of certain health-promoting diet components. The third derives from national food-based dietary guidelines, which many countries have now established for their citizens.

High-quality diets also need to be safe so that they do not cause foodborne disease (FBD). There is clear evidence of what constitutes unsafe food. We also consider the more recent proposal that the degree of processing is an indicator of diet quality and then assess what it will take to deliver high-quality diets into the future.

High-quality diets are those that eliminate hunger, are safe, reduce all forms of malnutrition, promote health and are produced sustainably i.e. without undermining the environmental basis to generate high-quality diets for future generations.

[33]FAO, WHO and UNU (2001) [34]FAO and WHO (2001) [35]Leroy et al. (2015); Schwingshackl and Hoffmann (2015)

2.2 Diet quantity and quality for vulnerable groups

Table 2.1 summarizes United Nations (UN) guidance on the diet of groups that are particularly vulnerable to undernutrition.[36] This includes infants up to the age of two, women and low-income households. For infants 0–6 months of age, breast milk provides them with all the nutrients they need. Beyond this age, the indicators emphasize dietary diversity. Dietary diversity is a well-known "qualitative measure of food consumption that reflects household access to a variety of foods and is also a proxy for nutrient adequacy of the diet of individuals."[37] The diversity scores listed in Table 2.1 measure how many food groups are represented by the foods consumed in a reference period: the more food groups, the higher the diet quality.[38] Taking the score involves measuring foods consumed from specific groups. All five diversity scores include starchy staples, fruits, vegetables, legumes, nuts, seeds and animal source foods (ASF) (e.g. meat, dairy, eggs, fish). Since these indicators were developed in the context of undernutrition, they do not account for the risk of excess intake of any specific food group in the diet. One of the scores for low-income households also includes oils/fats and sweets.

TABLE 2.1: UN guidance on diet quantity and quality for vulnerable groups

Group vulnerable to undernutrition	Measure of quantity and quality of diet	Foods included in the score	Threshold
Infants 0–6 months of age	Exclusively breastfed[39] (i.e. no other foods or liquids)	NA	Exclusivity threshold for individuals
Infants and young children 6–23 months of age	Minimum acceptable diet (MAD)[40]	Grains, roots, tubers; legumes and nuts; dairy products; flesh foods; eggs; vitamin A-rich fruits and vegs; other fruits and vegs	Indicator combines standards of dietary diversity and feeding frequency by breastfeeding status. Thresholds are contingent on these composite indicators.
	Minimum dietary diversity (MDD)[41]	As above	Score ranges from 0–7. A minimum recommended threshold is 4.
Women	Women's dietary diversity score (WDDS[42])[43]	Starchy staples; dark green leafy vegs (GLV); other vitamin A-rich fruits and veg; other fruits and vegs; organ meat; meat and fish; eggs; legumes/nuts/seeds; milk and products	As above
	MDD	Starchy staples; beans and peas; nuts and seeds; dairy; flesh foods; eggs; vitamin A-rich dark GLV; other vitamin A-rich vegs and fruit; other veg; other fruit	Score ranges from 0–10. Minimum recommended threshold is 5 foods per day.
Low-income households	Household dietary diversity score (HDDS)[44]	Cereals; white roots and tubers vitamin A-rich vegs and tubers; dark GLV; other veg; vitamin A-rich fruit; other fruit; organ meat/offal; flesh meat; eggs; fish and seafood; legumes, nuts, seeds; milk and products; oils and fats; sweets; spices/condiments/beverages	Score ranges from 0–12. No threshold but 12 is highest.

Source: Compiled by the authors

Only two out of 31 low-income countries and 12 out of 51 low to middle-income countries have food-based dietary guidelines.

[36]This is not an exhaustive list but it summarizes the most commonly used measures. [37]FAO and EU (2010) [38]Most of the indices specify the following food groups; starchy staples; beans and peas; nuts and seeds; dairy; flesh foods; eggs; vitamin A-rich dark green, leafy vegetables (GLV); other vitamin A-rich vegetables and fruits; other vegetables; other fruits (this is the set for the women's dietary diversity score [WDDS] in the table).
[39]WHO (2015a) [40]WHO, UNICEF, USAID, AED, UC Davis and IFPRI (2010) [41]WHO, UNICEF, USAID, AED, UC Davis and IFPRI (2010) [42]WDDS is also known as MDD-W (minimum dietary diversity for women of reproductive age) by FAO. [43]FAO and FHI 360 (2014) [44]FAO and EU (2010)

2.3 Diet quality for general populations

The second approach to defining high-quality diets has been developed in the context of populations that have attained a minimum calorie intake (albeit not exclusively) and offers recommendations on mixes of foods and diet components to minimize all forms of malnutrition as well as diet-related NCDs.

2.3.1 WHO guidance for a 'healthy diet'

The WHO has issued guidance of what comprises a 'healthy diet' on the basis of its scientific reviews of the evidence. Box 2.1 summarizes WHO's guidance. Although it emphasizes that a healthy diet starts early in life, the specific recommendations are for adults. They emphasize minimizing the intake of saturated and trans fats, free sugars and salt.

2.3.2 National food-based dietary guidelines

At the national level, governments have taken established scientific knowledge on high-quality diets and used it to develop food-based dietary guidelines (FBDGs). FAO describes these guidelines as:

> *"short, science-based positive messages on healthy eating and lifestyles aimed at preventing all forms of malnutrition and keeping people well-nourished and healthy. They embody national nutrition recommendations and express the principles of nutrition education in terms of food."*[45]

Over the last two decades, a growing number of countries have developed country-specific FBDGs. These guidelines represent recommendations from national governments to consumers on diets that promote health in the country's context. However, FBDGs are largely absent for low-income countries. Only 2 out of 31 low-income countries and 12 out of 51 low to middle-income countries have FBDGs. The percentage of countries with FBDGs rises to approximately 50% for the upper-middle- and high-income countries.

An analysis of 83 FBDGs is shown in Figure 2.1. It shows that:

- FBDGs broadly reflect the food-based WHO recommendations, although many do not specify recommended levels of food intake
- nearly all FBDGs stress the need to increase consumption of fruits and vegetables and most countries stress the need for a diverse diet
- nearly all FBDGs recommend lower consumption of sugar and salt. Over 75% of all FBDGs recommend reducing sugar consumption.
- around half of countries refer to the importance of safe food (see Section 2.4)
- few countries make reference to wholegrains
- less than 25% of FBDGs recommend reducing or moderating meat intake (although no details are provided on the kind of meat)[46]
- FBDGs in some countries, for example Brazil, recommend the avoidance of 'ultra-processed' foods high in fats, sugars and salt (see Section 2.5)
- very few FBDGs explicitly mention environmental concerns (see Section 2.6).

Box 2.1: World Health Organization (WHO) guidance on healthy diets

- A healthy diet helps protect against malnutrition in all its forms, as well as non-communicable diseases (NCDs), including diabetes, heart disease, stroke and cancer.
- Healthy dietary practices start early in life – breastfeeding fosters healthy growth and improves cognitive development. It may also have longer term health benefits, such as reducing the risk of becoming overweight or obese and developing NCDs later in life.
- Energy intake (calories) should be in balance with energy expenditure.
- A healthy diet includes fruits, vegetables, legumes (e.g. lentils, beans), nuts and wholegrains (e.g. unprocessed maize, millet, oats, wheat, brown rice).
- At least 400 g (five portions) of fruits and vegetables a day. Potatoes, sweet potatoes, cassava and other starchy roots are not classified as fruits or vegetables.
- Total fat should not exceed 30% of total energy intake to avoid unhealthy weight gain, with a shift in fat consumption away from saturated fats to unsaturated fats and towards the elimination of industrial trans fats.
- Limiting intake of free sugars to less than 10% of total energy intake is part of a healthy diet. A further reduction to less than 5% of total energy intake is suggested for additional health benefits.
- Keeping salt intake to less than 5 g per day helps prevent hypertension and reduces the risk of heart disease and stroke in the adult population.

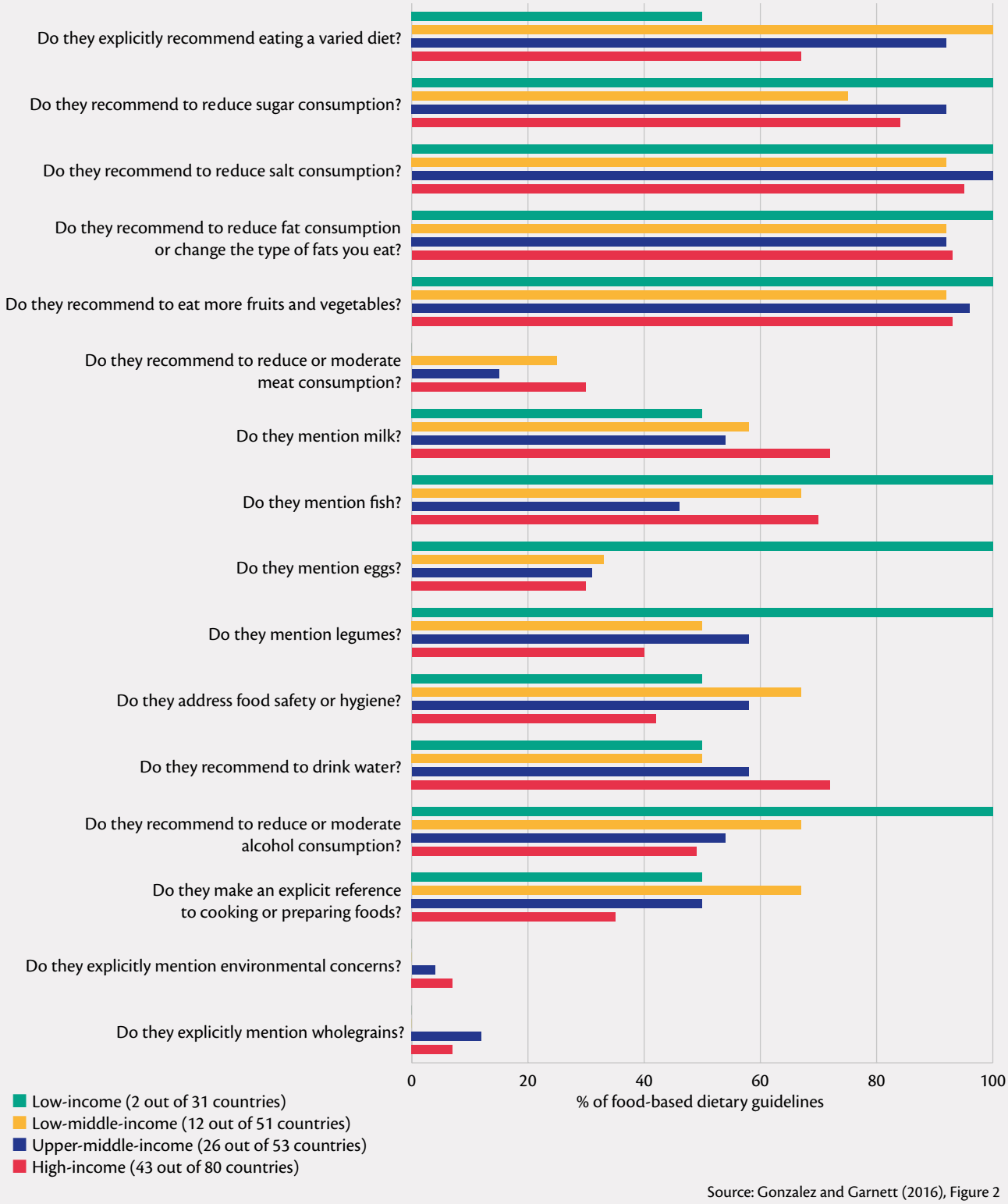
Source: WHO (2015a)

[45]FAO (2016b)

[46]Lower-income guidelines also recommend exclusive breastfeeding in the first six months of life and ensuring that the salt that is consumed is iodized.

There are some notable differences between countries at different income levels. Recommendations on food safety and hygiene become less frequent from lower-middle-income to high-income FBDGs, as do recommendations on cooking and preparing foods, perhaps reflecting the greater risks in lower-middle-income countries. Interestingly, the emphasis on consuming a varied diet is stronger for middle-income countries than it is for high-income countries.

FIGURE 2.1: What 83 national food-based dietary guidelines (FBDGs) recommend



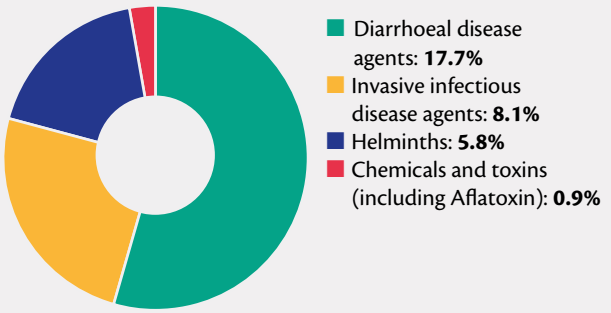
Source: Gonzalez and Garnett (2016), Figure 2

2.4 Safe diets

Around half of all countries refer to the importance of consuming safe foods in their food-based dietary guidelines (Figure 2.1) reflecting the fact that diets cannot be high-quality if they are unsafe.[47] Unsafe food means food that is contaminated with agents that cause disease (see Box 2.2).

As a result of the combined causes shown in Box 2.2, WHO[49] estimates that, worldwide in 2010 there were 600 million cases of foodborne illness, causing 34 million disability-adjusted life years (DALYs) and 420,000 deaths.

FIGURE 2.2: The global burden of foodborne disease (total DALYs) by hazard groups, 2010



Source: Compiled by the authors, based on WHO (2015b), Table 7

Where regional estimates are available, Figure 2.3 shows that in African countries, diarrhoeal disease agents are responsible for the vast majority of the foodborne DALY burden. In South-East Asian countries, the burden is equally shared between diarrhoeal disease and invasive infectious disease agents. There are no projections of foodborne DALYs, but given the rapid pace of urbanization and growing slum populations, the consumption of prepared street food and food prepared outside the home, it is likely that the number of DALYs per 100,000 people will increase.

Box 2.2: Agents which cause foodborne disease

- **Microbial pathogens** e.g. rotavirus, Salmonella spp., Campylobacter spp., toxigenic Escherichia coli. This group is the most important source of foodborne disease (FBD) and responsible for diarrhoeal diseases, and for over half of all foodborne disability-adjusted life years DALYs (Figure 2.2). They lead to billions of cases of illness and over 100 million DALYs each year in low-middle-income countries. They are found mainly in animal source foods and fruits and vegetables.

- **Foodborne macro-parasites** e.g. tapeworms; fish and aquatic animal associated fluke (common in South-East Asia); roundworms and whipworms. Foodborne macro-parasites are responsible for around 1.4 billion cases and a burden of 5.8 million DALYs each year (Figure 2.2). They are found mainly in livestock and seafood.

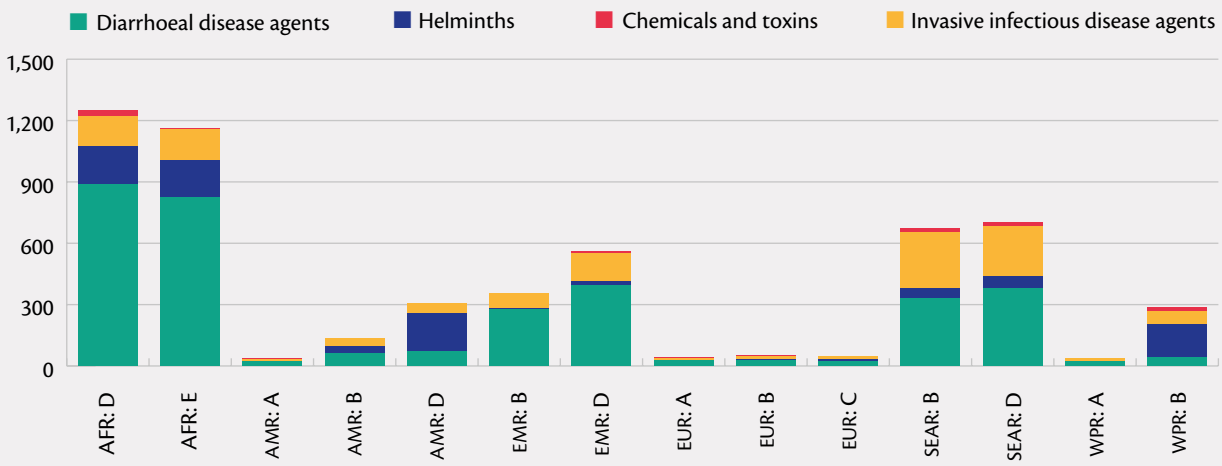
- **Toxins and chemicals** The leading source is aflatoxins – fungal toxins, which contaminate mainly staple crops such as maize and groundnuts.[48] They are widespread in tropical and subtropical developing countries. Responsible for an estimated 90,000 annual deaths from liver cancer and around 1.5 million DALYs, they are also associated with stunting in children. Plant toxins and marine toxins (e.g. diarrhetic shellfish poisoning) are responsible for tens of thousands of cases of illness. Chemicals such as arsenic, cadmium, mercury, dioxins and highly hazardous pesticides can contaminate food; other toxins (e.g. polycyclic aromatic hydrocarbons and acrylamide), are formed by smoking, grilling, roasting and frying food.

Source: Compiled by the authors, based on Grace (2015)

Microbial pathogens ... lead to billions of cases of illness and over 100 million disability-adjusted life years (DALYs) each year in low-middle-income countries.

[47]FAO and WHO (2007); Grace (2015); Global Panel (2016b)
[48]Unnevehr and Grace (2013)
[49]WHO (2015b)

FIGURE 2.3: The global burden of foodborne disease (DALYs per 100,000 population) by hazard groups and by subregion, 2010



Source: Compiled by the authors, based on WHO (2015b), Table 8

Note: AFR = Africa; AMR = the Americas; EMR = Eastern Mediterranean; EUR = Europe; SEAR = South-East Asia; WPR=Western Pacific. A = very low child and adult mortality; B = low child mortality and very low adult mortality; C = low child mortality and high adult mortality; D = high child and adult mortality; and E = high child mortality and very high adult mortality.

2.5 The role of food processing in diet quality

FBDGs are typically based on "wholefoods", such as fruits rather than fruit juice, potatoes rather than potato chips and sugar rather than biscuits/cookies. However, as we show in Chapter 3, the amount of foods in the global diet that have undergone various degrees of processing is increasing.

While there are no official international guidelines available to date on the recommended amount of foods with differing degrees of processing, in 2014, the Brazilian Food Guide set a precedent by referring to the degree of food processing. Specifically, it recommends that high-quality diets contain minimal amounts of "ultra-processed foods." The term "ultra-processed" was coined to refer to industrial formulations manufactured from substances derived from foods or synthesized from other organic sources. They typically contain little or no wholefoods, are ready-to-consume or heat up and are fatty, salty or sugary and depleted in dietary fibre, protein, various micronutrients and other bioactive compounds.[50] Examples include: sweet, fatty or salty packaged snack products, ice cream, sugar-sweetened beverages, chocolates, confectionery, French fries, burgers and hot dogs, and poultry and fish nuggets.[51]

In 2015, WHO's regional office for the Americas, Pan-American Health Organization (PAHO), released a report[52] on trends in the sales of "ultra-processed" foods. The PAHO report[53] suggests that the proportion of ultra-processed products in food supplies can be seen as a measure of overall population diet quality. This is because these foods have very high energy densities, are high in free sugars, unhealthy fats and salt and are low in dietary fibre, all of which increase the risk of obesity and other diet-related NCDs.

The PAHO report notes that other forms of processing can be beneficial for diet quality. Processed foods such as pasteurized milk, bread made through fermentation, canning and freezing vegetables and flours made from legumes, all provide important opportunities for preserving foods, converting inedible into edible foods and converting difficult-to-prepare foods into nutritious and convenient forms. These processing methods can help to increase food availability, extend seasonality through the 'hunger gap' and importantly, make food safer to eat.

[50]PAHO (2015) [51]The full list is too extensive to reproduce here and can be found in Annex 4 [52]PAHO (2015) [53]See Vandevijvere et al. (2013) work

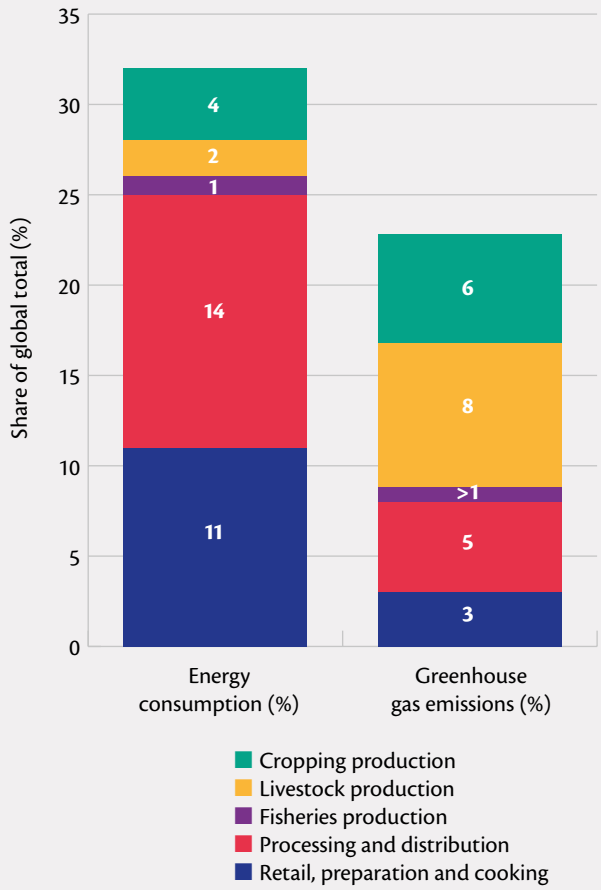
2.6 Sustainable diets

In 2010, FAO introduced the concept of "sustainable diets", defined as:

> *"diets 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 optimising natural and human resources."*[54]

Sustainability, however, is only incorporated in a small number of FBDGs (Figure 2.1). Four countries have official guidelines that include sustainability (Brazil, Germany, Sweden, Qatar) and some countries have quasi-official guidelines that refer to sustainability for example, Netherlands, Norway, Iceland and France.[55]

FIGURE 2.4: The food system's contribution to total global energy consumption and greenhouse gas emissions



Source: 2016 Global Food Policy Report, Figure 3 (IFPRI 2016b)

There is considerable debate around the relationship between high-quality diets from a nutritional perspective and from an environmental perspective. Are diets that are environmentally sustainable and make efficient use of limited natural resources healthy for humans? Or do countries face a trade-off between eating healthily and conserving the natural resource base on which people depend on for food, particularly in regions that are under ever-greater pressure from growing populations and changing climate?

Figure 2.4 provides an overview of the global food system's contribution to total global energy consumption as well as to greenhouse gas emissions. It is important for two reasons. First, it shows the food production/post-production shares of energy use and greenhouse gas emissions. Both the components of the food system (production/post-production) have significant impacts on the environment. It is critical therefore to consider the entire food system and not just part of it when examining environmental footprints. Second, it demonstrates that food production produces 2.7 times more greenhouse gas emissions than post-production processes, while the latter uses 3.5 times more energy than food production does. This shows why it is essential to look at different environmental dimensions of food systems when considering whether high-quality diets in the future will be environmentally sustainable. Very few studies analyze the various parts of the food system from an environmental perspective.

At a global level, most research on diets and the environment has focused on modelling greenhouse gas reduction. For example, greenhouse gas emissions are lower for stylized Mediterranean, pescatarian and vegetarian diets compared to the current global average diet.[56] Another global study,[57] which compares baseline emissions in the year 2005/07, suggests that a projected 51% increase in food-associated greenhouse gas emissions by 2050 would be reduced to a 7% increase if diets in line with global dietary guidelines were adopted globally.

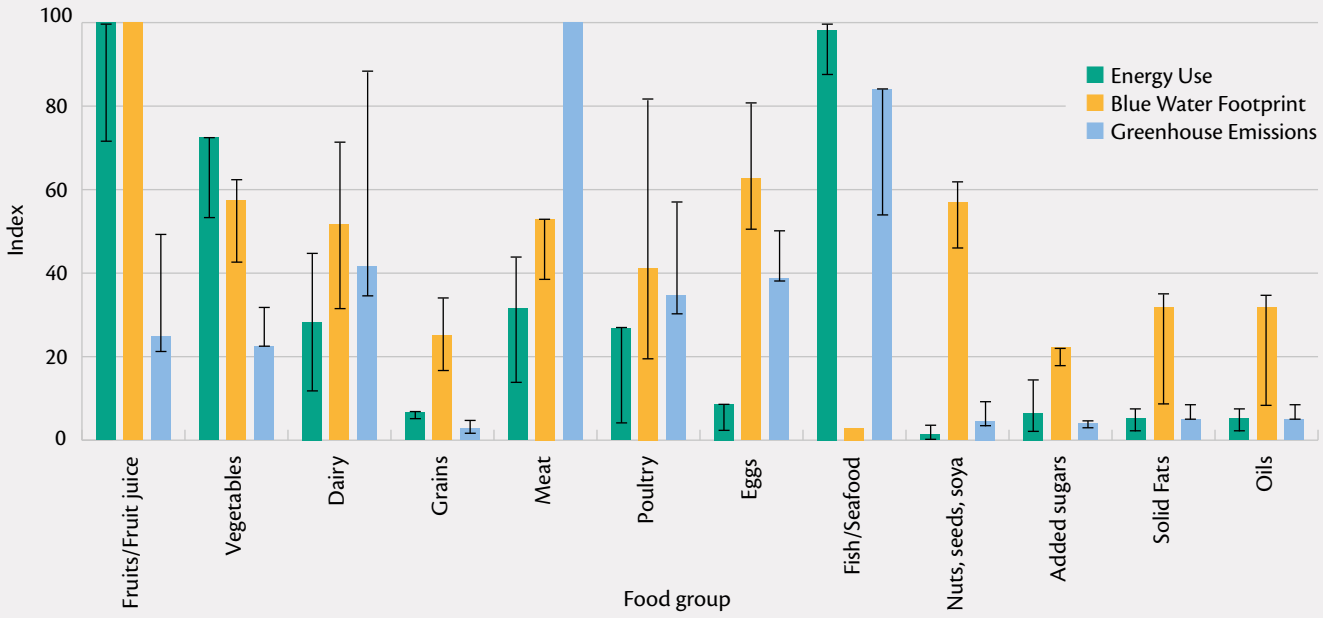
At the country level, estimates[58] optimizing the UK diet in line with WHO guidelines (i.e. increasing fruits and vegetables intake and reducing red meat and processed meat intake) could lead to a decrease of 17% in greenhouse gas emissions and increase average life expectancy by eight months.

But greenhouse gas emissions represent only one dimension of a diet's environmental footprint. A global analysis[59] of the carbon and water footprint of different foods within food groups such as fruits, vegetables, oils and nuts shows considerable variation in ecological footprints. They conclude that there are many synergies between a diet that is both good for health and the environment, as long as the most sustainable production choices are made for each food group.

[54]Burlingame and Dernini (2010) [55]Gonzalez Fischer and Garnett (2016)
[56]Tilman and Clark (2014) [57]Springmann et al. (2016) [58]Milner et al. (2015) [59]Downs and Fanzo (2015)

Data for the United States (US)[60] illustrate the levels of energy and resource use for the consumption of different food groups (Figure 2.5). The results show that there is a challenge, at least in this case, of trying to align nutrition, energy use, water use and greenhouse gas emissions. For example, while the consumption of plant foods produces lower greenhouse gas emissions per calorie than animal-based foodstuffs, the consumption of fruits and vegetables (nutritionally positive) uses more 'blue water' (i.e. water derived from rivers, lakes and aquifers) and energy per calorie than less healthy food items such as added sugars.

FIGURE 2.5: Indices of average energy use, blue-water footprint and greenhouse gas emissions per calorie of food for each food group, US data



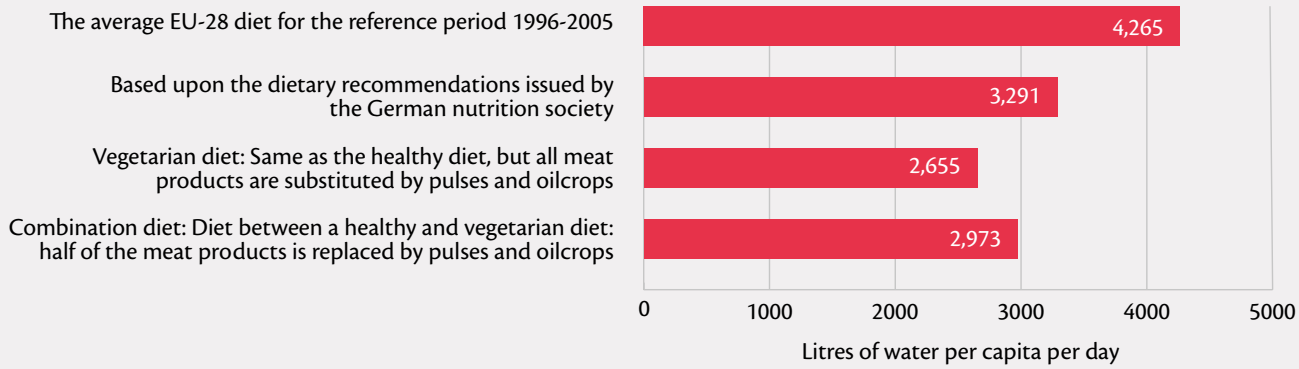
Source: Tom, Fischbeck and Hendrickson (2015)

Note: A score of 100 represents the highest resource use and emissions per calorie. Scores were developed based on the weighted averages of energy use, blue-water footprint and greenhouse gas emissions per calorie estimates for comparable food types within each food group.

Estimates suggest that the expected 51% increase in food-associated greenhouse gas emissions by 2050 would be reduced to a 7% increase if WHO guideline diets were adopted globally.

[60]Tom, Fischbeck and Hendrickson (2015)

FIGURE 2.6: The water-use consequences of different diets in the EU-28 countries



Source: Compiled by the authors, based on Vanham, Mekonnen and Hoekstra (2013)

While these costs will be different for the same foods in other countries, particularly with respect to energy costs involved in processing and food chains, these patterns suggest that aligning high-nutrition, low-resource footprints and low-carbon footprints will not be straightforward. More analyses of this kind for a much wider range of food systems are needed to give policy makers greater guidance.

Research is also needed which focuses on diets rather than the consumption of individual foods. When diets are reviewed, the diversity of foods involved produces fuller and more rounded pictures of nutritional and environmental trade-offs. For example, in the 28 European Union (EU) countries, it has been estimated[61] that the consumption of healthier diets generates lower total water[62] footprints (see Figure 2.6).

Achieving a balance between diets that are high quality and those that are environmentally sustainable may look challenging, but as the science advances our understanding of how to do this will improve. A small but increasing number of countries is beginning to consider sustainability in their food-based dietary guidelines. Brazil, Germany, Japan, Sweden and Qatar include messages related to sustainability, food waste and leftovers in their FBDGs.[63] And while the latest US Dietary Guidelines for Americans 2015[64] do not explicitly include sustainability, the report behind the guidelines acknowledges that:

> *"plant-based diets are associated with lower resource use than diets higher in animal products and lowered resource use will be important in ensuring long-term food security".*

Aligning high-nutrition, low-resource footprints and low-carbon footprints will not be straightforward. More analyses of this kind for a much wider range of food systems are needed to give policy makers greater guidance.

[61]Vanham, Mekonnen and Hoekstra (2013) [62]Not just blue water (from irrigation and rivers) but also green water (rainfall) and grey water (water needed to control waste). [63]González Fischer and Garnett (2016) [64]U.S. Department of Health and Human Services and USDA (2015)

2.7 Implications

The objective in this chapter has been to build a clear picture of a high-quality diet, which can be used to guide food systems policy. As noted at the start of the chapter, this is not straightforward. One of most complex areas is meat consumption. For groups with high micronutrient requirements and low meat consumption, such foods offer important opportunities to increase micronutrient intake. For groups with meat consumption levels that are already high, the advice is to moderate intake levels. However, it is possible to draw together the elements of what is currently recommended for high-quality diets, as we do in Box 2.3.

Given the coexistence in many low- and middle-income countries of the continued presence of hunger and growing levels of overweight and obesity, policy makers face major challenges in defining high-quality diets for their populations. But these challenges mean it is now even more important to define such diets. Not enough low-income countries have FBDGs. These countries will need to generate and promote dietary guidelines that both improve the diets of those who are not eating enough food and improve the diets of those who are consuming levels of certain foods and components above recommended levels. Also, besides offering guidance to consumers, FBDGs need to guide policy decisions across food systems. This is not currently general practice and is a missed opportunity.

Box 2.3: Elements of a high-quality diet

Drawing the evidence together with an emphasis on adequacy, diversity and balance, current recommendations from UN agencies, governments and scientific bodies point towards the following choices for ensuring a high-quality diet for all people over two years of age:

- Eat a diverse diet drawing on as many food groups as possible.
- Consume diets that contain plenty of wholegrains, fruits and vegetables, fibre and nuts and seeds.
- Unless a vegetarian or intolerant to dairy, consume eggs, moderate amounts of dairy (mainly milk), fish and small amounts of meat.
- Avoid or consume low levels of added sugars, sugary snacks and beverages.
- Avoid or consume low levels of processed meat.
- Replace saturated and industrial trans fats with unsaturated fats.
- Eat low levels of salt and ensure that all salt that is consumed is iodized.

Babies under six months of age should consume only breast milk; infants and young children 6–23 months of age should continue to consume breast milk but consume complementary foods that are sufficiently diverse and nutrient-dense to promote optimal child growth.

The food consumed needs to be free of foodborne disease agents and toxins. There is a tension here since many fresh, perishable foods, which can contribute to a high-quality diet – e.g. fruits and vegetables, dairy and fish – are also the leading sources of foodborne disease.

Food processing can be beneficial for the promotion of high-quality diets; it can make more food more available as well as making food safer. However, some forms of processing can lead to very high densities of salt, added sugar and saturated fats and these products, when not consumed in low amounts, will undermine diet quality.

To be accessible to future generations, high-quality diets need to be produced, processed, distributed and prepared in ways that use natural resources sustainably and mitigate the generation of greenhouse gases.

Source: Compiled by the authors


UCOSE
BISCUITS
Wrimer
Bekars

3 How diets are changing

KEY MESSAGES

- Huge numbers of people worldwide have diets that are deficient in adequacy, diversity and balance.
- Many infants are not breastfed despite WHO guidance.
- Only a small proportion of infants from low- and middle-income countries are meeting minimum recommended dietary standards.
- In low- and middle-income countries, more than half of adolescent girls (10-20 years) surveyed are consuming monotonous, starch-based diets with low diversity, which do not meet their micronutrient needs.
- Over time, people are consuming more recommended components of high-quality diets. However, despite dietary improvements, the net result is still a prevalence of low-quality diets in most countries.
- Sales of ultra-processed food and sugar-sweetened beverages are growing. This growth is almost exclusively found in lower-middle-income and upper-middle-income countries.
- Income growth does not guarantee healthier diets. Countries cannot simply 'grow' their way out of poor diet quality.
- The lack of data on what people actually consume around the world needs urgent attention from policy makers.

3 How diets are changing

Over half of adolescent girls in low- and middle-income countries do not get micronutrients that are vital for good health (iron, zinc, calcium, vitamin D, folate, thiamin and riboflavin).

While there is enough scientific evidence to broadly establish high-quality diets that are beneficial for preventing malnutrition in all its forms, recommendations in international and national guidelines have not been accompanied by major changes in dietary patterns around the world. Large numbers of people have diets that are inadequate, not diverse and balanced.

Our ability to describe diets is hampered by fragmented and incomplete data. Much of the data available are not on what people actually eat, but on what is produced, sold or purchased, from which diets are estimated based on a range of assumptions. This important distinction is explained in Box 3.1. The lack of sound, empirical data represents a serious hurdle to policy makers who seek to design evidence-based policies aimed at promoting healthier diets. This significant data gap needs to be urgently addressed.

Box 3.1: Diet and food intake: Data challenges

Assessing the quality of diets is challenging. Different combinations of food intake are not easily aggregated and the availability of internationally comparable data is poor. There are no standard protocols for collecting data on food intake and a plethora of methods are used, each with its own strengths and weaknesses and at irregular intervals. This has led to a highly disparate set of intake estimates and the process of integrating them has only recently begun (See Appendix 2, Table 3.1).

Many analysts use FAO food balance sheets as proxies for diet intake although recent work has shown a variable correspondence between food availability and food intake.[65] In this report, food balance data are used in Chapters 6 and 7 as a valuable resource to estimate past and future changes in food supply. For diets, data from the Global Dietary Database[66] are drawn upon. This database brings together data from 266 country-specific nutrition surveys for 187 countries between 1990 and 2013. In 2014, the database released data on a select number of 'healthy' and 'unhealthy' components of diet (Appendix 3 Table 3.2).

Source: Compiled by the authors

In this chapter, data from a variety of sources are used to examine dietary trends from several perspectives: how diets have changed among adults, infants, young children, women and households experiencing poverty. Because of the growing importance of ultra-processed foods in diets we also examine trends in their sales.

Our ability to describe diets is hampered by fragmented and incomplete data.

Sales of ultra-processed foods in East and South-East Asia are expected to approach those of high-income countries by 2035.

[65]Del Gobbo et al. (2015) [66]Global Nutrition and Policy Consortium (2014)

3.1 Data from the global dietary database

3.1.1 The database

In 2014, Tufts University in the US established the Global Dietary Database as a means of drawing together household surveys that measure actual diets. Although the data released to date do not include all food groups or the granular detail required for measurements of diet diversity outlined in Chapter 2, they are, in our view, the best collation of diet data available.[67] They represent an improvement over the use of food supply data as a proxy for diet, as has commonly been done in the past on research on changing diets (see Box 3.1).

The data released by the initiative divides food items and diet components into those categorized as 'healthy' and 'unhealthy' as they are related to NCDs such as coronary heart disease, stroke and diabetes (see Appendix 3 Table 3.2 for definitions).

These categorizations are based on systematic reviews of the latest scientific evidence on the links between food intake and NCDs. The list in Table 3.1 shows dietary risks considered and the consumption ranges assumed to avoid disease risk. The dietary risk factors are ranked in order of importance from the top going down i.e. the number of people affected by consumption levels and the strength of association with various diseases.

These categories are mostly consistent with international and national guidelines reviewed in Chapter 2, with the exception of red meat which is labelled as "unhealthy", but which in nutrient deficient contexts can be an important means of increasing micronutrients in the diet.

In the next section, publicly available data from the Global Dietary Database on foods considered to have a large influence on diet quality are summarized to outline current levels of consumption, trends over time and trends across income groups.

TABLE 3.1: Dietary risks considered in the Global Burden of Disease Study

Food/diet risk component (ranked based on most DALYs generated: top generates the most)	Theoretical minimum risk exposure level (range to avoid health risk)
Diet low in fruits	Consumption of fruit between 200 g and 400 g per day
Diet high in sodium	Consumption of sodium between 1 g and 5 g per day
Diet low in wholegrains	Consumption of wholegrains between 100 g and 150 g per day
Diet low in vegetables	Consumption of vegetables between 350 g and 450 g per day
Diet low in nuts and seeds	Consumption of nuts and seeds between 12 g and 20 g per day
Diet low in seafood omega-3 fatty acids	Consumption of seafood omega-3 fatty acids between 200 mg and 300 mg per day
Diet low in fibre	Consumption of fibre between 28 g and 32 g per day
Diet high in processed meat	Consumption of processed meat between 0 g and 14.3 g per day
Diet low in polyunsaturated fatty acids	Consumption of polyunsaturated fatty acids between 10% and 15% of total daily energy
Diet high in trans fatty acids	Consumption of trans fatty acids between 0% and 0.8% of total daily energy
Diet high in sugar-sweetened beverages	Consumption of sugar-sweetened beverages between 0g and 64.3 g per day
Diet high in red meat	Consumption of red meat between 11.4 g and 17.1 g per day
Diet suboptimal in calcium	Consumption of calcium between 0 g and 0.77 g per day
Diet low in milk	Consumption of milk between 425 g and 475 g per day

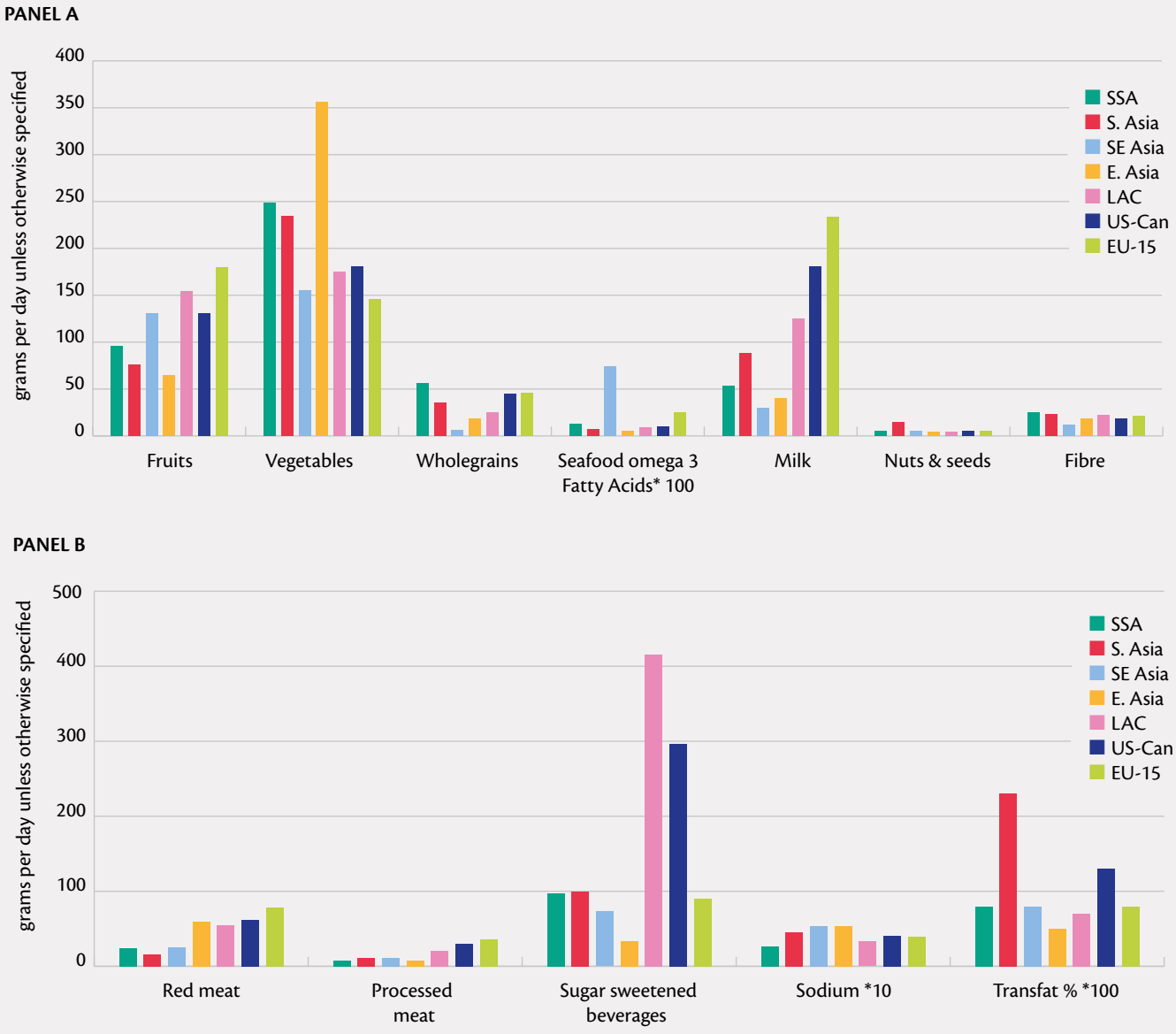
Source: Global Burden of Disease Study 2013 Collaborators (2015), Table 1

[67] FAO and WHO are developing a Global Individual Database on Food Intake (GIFT), which, once completed, promises to represent an additional valuable resource on diets.

3.1.2 Current consumption

Analysis of the Global Dietary Database food intake data reveals substantial variation in food consumption in different regions (see Figure 3.1, Panels A and B). From Panel A, we can see that fruit consumption tends to increase from lower- to-higher income regions while vegetable consumption declines. Consumption of seafood omega-3 fatty acids, present in fatty fish, is over 70% higher in South-East Asia compared to other regions. This is in contrast to dairy intake where consumption exceeds 200 g/day in Europe, compared to <40 g/day in South-East Asia. From Panel B, we can see that red meat consumption is similar in East Asia, Latin America, North America and the EU-15. Trans fat intake is highest in South Asia. Notably, the relative consumption of sugar-sweetened beverages exceeds 400 g/day in Latin America, followed closely by North America in contrast to East Asia, where intakes are ten-fold lower (~40 g/day).

FIGURE 3.1: Intake of key foods and diet components, by region, 2013



Source: Masters (2016), based on data from the Global Dietary Database

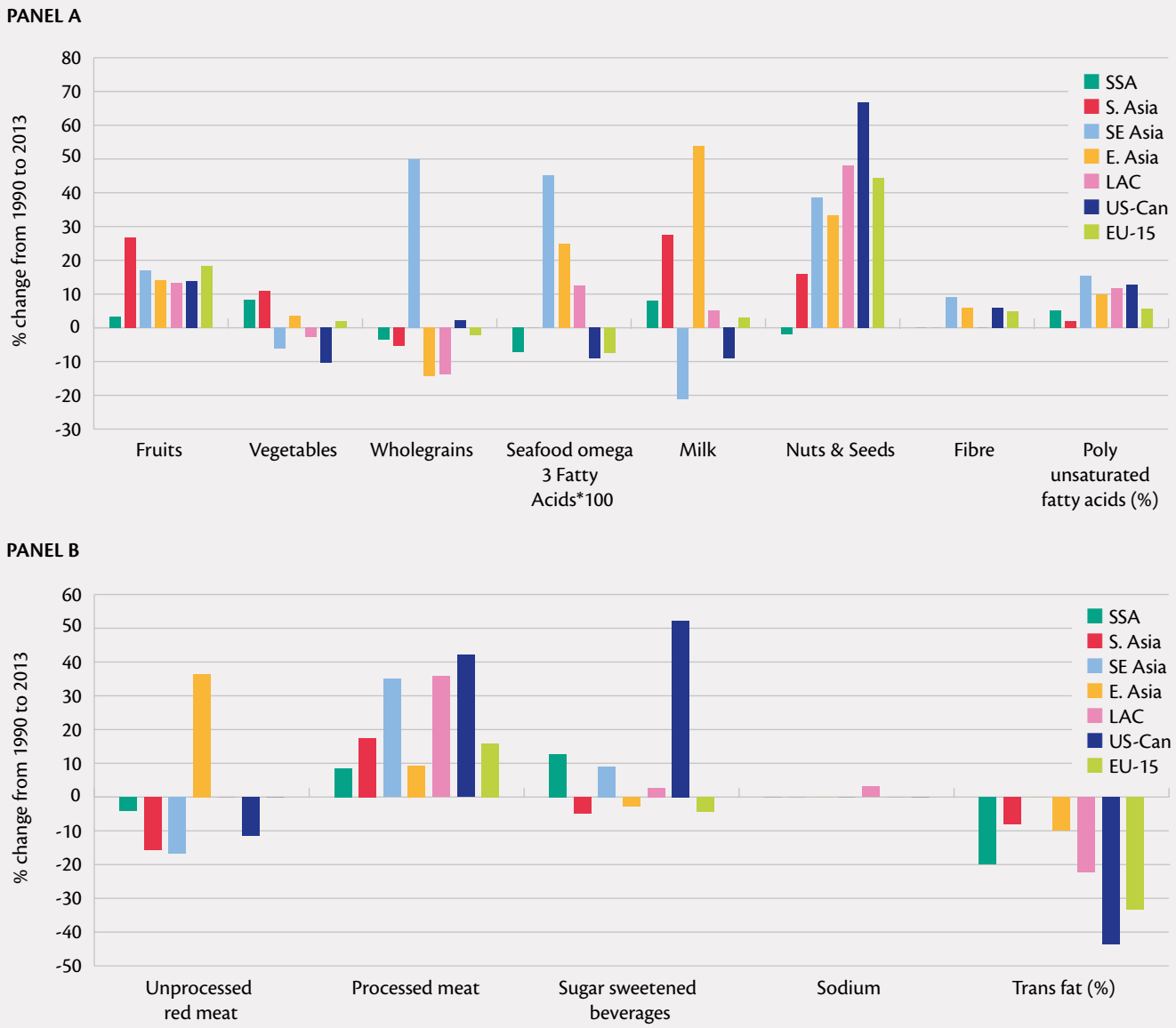
Note: SSA: sub-Saharan Africa; S. Asia: South Asia; SE Asia: South-East Asia; E. Asia: East Asia; LAC: Latin America and the Caribbean; US-Can: USA and Canada; EU-15: European Union 15.

3.1.3 Change over time

In general, the consumption of the foods and diet components in Panel A (the 'healthy' items) has grown in all regions over the past decade and only about 5% show declines in a few areas (see Figure 3.2). However, there are some important differences across food types. Fruit consumption is increasing in all regions, while vegetable consumption is increasing in only four out of seven regions. Intake of wholegrains is rising substantially only in South-East Asia, while consumption of seafood omega-3 fatty acids is declining in three out of seven regions.

Income growth is a double-edged sword when it comes to diet quality.

FIGURE 3.2: Changes in intake of key foods and diet components by region, 1990-2013 (%)



Source: Masters (2016), based on data from the Global Dietary Database.

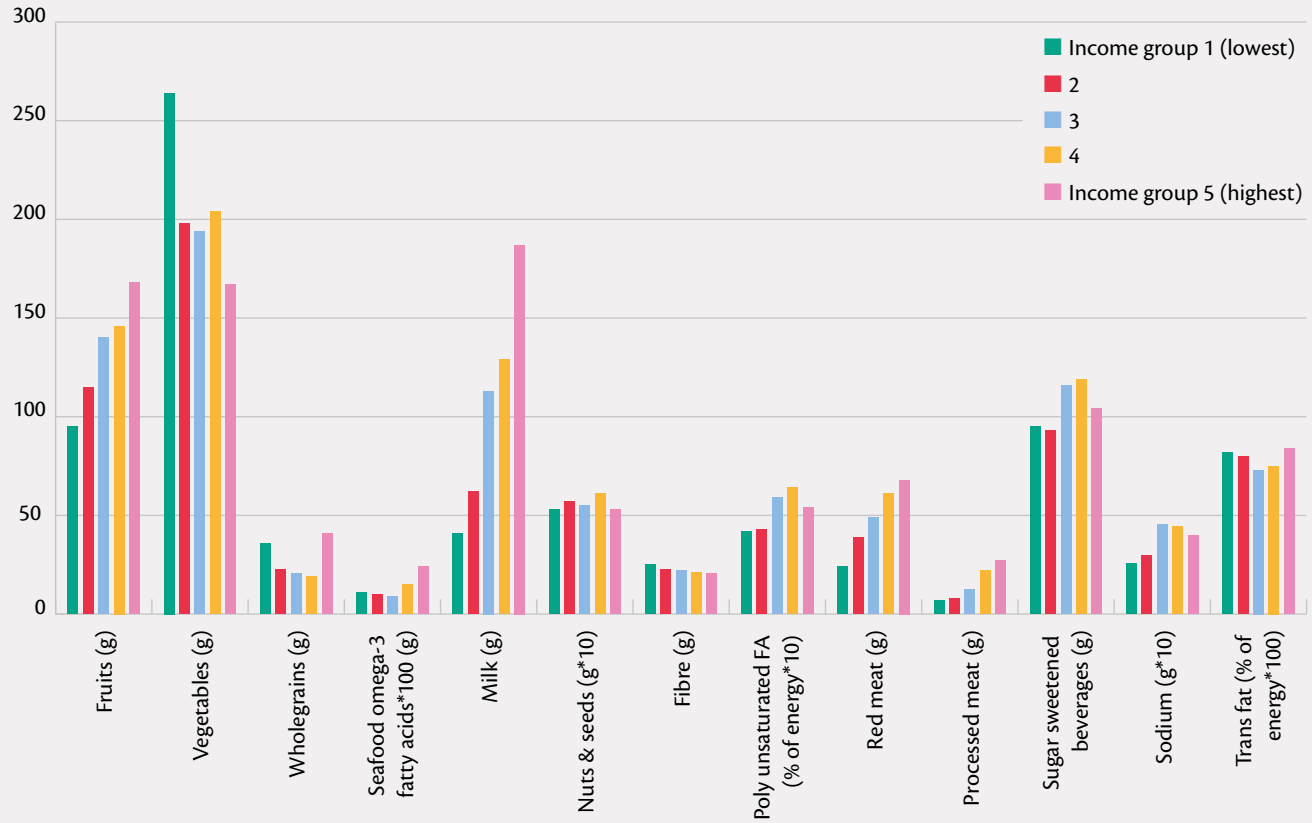
Note: SSA: sub-Saharan Africa; S. Asia: South Asia; SE Asia: South-East Asia; E. Asia: East Asia; LAC: Latin America and the Caribbean; US-Can: USA and Canada; EU-15: European Union 15.

The changes in consumption patterns for the foods and diet components in Panel B (the so-called 'unhealthy' items) are mixed (see Fig. 3.2). The picture for trans fats is encouraging, with declines in all regions. Red meat consumption has declined everywhere except in East Asia where it has risen by nearly 40%.[68] The consumption of processed meat has risen in all regions while sugar-sweetened beverage consumption has risen in more than half of the regions, with the largest increase in North America during the period. Changes in salt/sodium consumption have been minimal in all regions.

3.1.4 Changes with national income level

Analysis of the impact of income level on diet changes across countries in Figure 3.3 shows that as countries get wealthier, the consumption of foods that are associated with high-quality diets (the so called 'healthy' components) increase. But the consumption of those associated with low-quality diets increase even more strongly. For example, as national income increases, the consumption of fruits, seafood and milk rise, as does the share of polyunsaturated fats, but vegetable consumption declines, as does fibre. Red meat consumption increases and so too does the consumption of less healthy foods and diet components such as processed meat, sugar-sweetened beverages and sodium. The consumption of trans fats stays constant. While the effects on the overall quality of the diet are not clear, Figure 3.3 illustrates how income growth is a double-edged sword when it comes to diet quality. Increased levels of income certainly enable higher-quality diets, but they also enable lower-quality diets.

Figure 3.3: Consumption of foods and other diet components by national income group, 2013



Source: Compiled by the authors, based on data provided by Masters (2016)

[68]The decline in South and South-East 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.

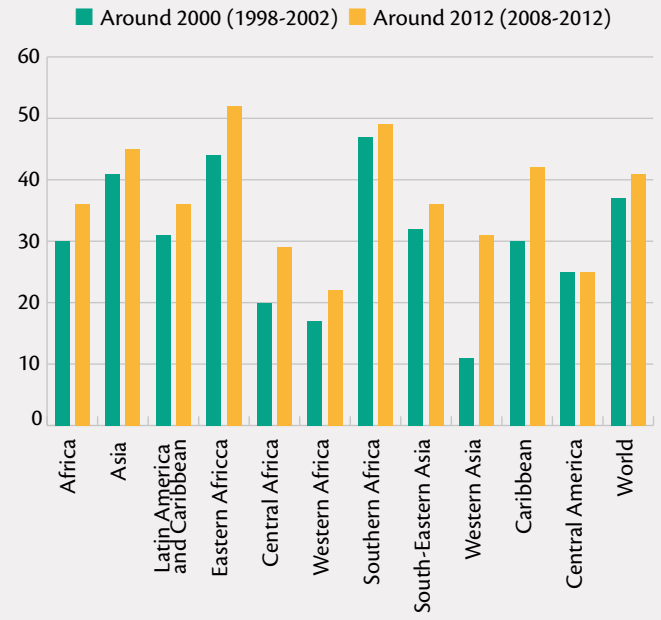
But the trends in Figure 3.3 are not predestined for the lower- and middle-income countries. As their income increases, they do not have to emulate high-income countries: they can increase the consumption of foods that are consistent with a high-quality diet, while keeping in check the consumption of foods that are not.

South Korea is a good example of a country with income levels that have grown rapidly but where obesity rates have remained low (at approximately 6% compared to the UK's 28%).[69] Why South Korea has been able to chart this course is not entirely clear. It is thought that some combination of a healthy traditional diet, excellent monitoring of diet in annual surveys and the implementation of a range of food systems policies designed to encourage the availability and consumption of foods consistent with a healthy diet are responsible for this trend.[70]

3.2 Diets of important population subgroups

The data from the Global Dietary Database are not available for different age and gender categories and regular diet surveys may not cover the particular dietary needs of certain age groups. Yet as the previous chapter outlined, there are some very important groups of individuals that have special nutrition requirements throughout their life cycle. Here we draw on specialized data to fill the gap.

FIGURE 3.4: Percentage of infants age 0-5 months who are exclusively breastfed by region, around 2000 and 2012



Source: 2014 Global Nutrition Report, Figure 3.3, IFPRI (2014)

From birth to five months of age

The latest data indicate that only a small fraction of all babies in the world meet dietary recommendations. The number of babies who are exclusively breastfed is rising slowly in low- and middle-income countries (Figure 3.4). This is due, in part, to active promotion campaigns[71] but gains are at risk due to weak implementation of the International Code on the Marketing of Breast-milk Substitutes into national legislation (only 39 countries out of 193 have fully enshrined the Code in legislation).[72] Between 2008 and 2013, total world milk formula sales volume grew by 40.8%, from 5.5 to 7.8 kg per infant/child/year and is projected to increase by 30.4% to 10.8 kg in 2018, with growth led by the infant (0–6 months) and follow-up (7–12 months) categories.[73]

Infants and young children

For infants and young children aged 6–23 months, WHO recommends that breast milk consumption should continue, complemented by the intake of foods that are sufficiently energy-dense and diverse to promote optimal growth. WHO recommends two indicator thresholds to assess the diet quality of infants and young children: the percentage of 6–23 month olds who attain a minimum diet diversity (MDD) and the percentage who attain a minimum acceptable diet (MAD). Between them, they measure diet quality for this age group.[74]

For the low- and middle-income countries where data are available, the percentages are low. An average of 28% of infants are consuming minimum dietary diversity (MDD) across 60 countries for which we have data and an average 15% of infants are consuming a MAD in 50 countries for which data are available (Table 3.2).[75] However, the range is wide for both indicators, at 5–90% and 3–72% respectively, suggesting the potential for improvements even within a low- and middle-income context.

[69]IFPRI (2016a) [70]IFPRI (2015a) [71]IFPRI (2014) [72]IFPRI (2016a) [73]Baker et al. (2016) [74]IFPRI (2014) [75]IFPRI (2016a)

TABLE 3.2: The percentage of infants and young children meeting WHO minimum recommended standards for diet in low- and middle-income countries

Indicator of coverage of interventions	Number of countries with data	Percentage of infants and young children 6–23 months of age who meet the minimum recommended levels		
		Median for countries with data	Lowest Prevalence	Highest prevalence
Children 6–23 months who receive MDD	60	28	5	90
Children 6–23 months who receive a MAD	50	15	3	72

Source: 2016 Global Nutrition Report, Table 5.1, IFPRI (2016a)

Adolescent girls and young women

The nutrition status of adolescent girls is low due to the loss of nutrients through menstruation; it is also a time when many of them are getting ready to become mothers. A recent major review of the quality of the diets of adolescent girls (10–20 years) in a wide range of low- and middle-income countries[76] found that there have inadequate levels (by at least 50%) of: iron, zinc, calcium, vitamin D, folate, thiamin and riboflavin – micronutrients that are all vital for the good health of the girl and any babies she may give birth to. It concludes that:

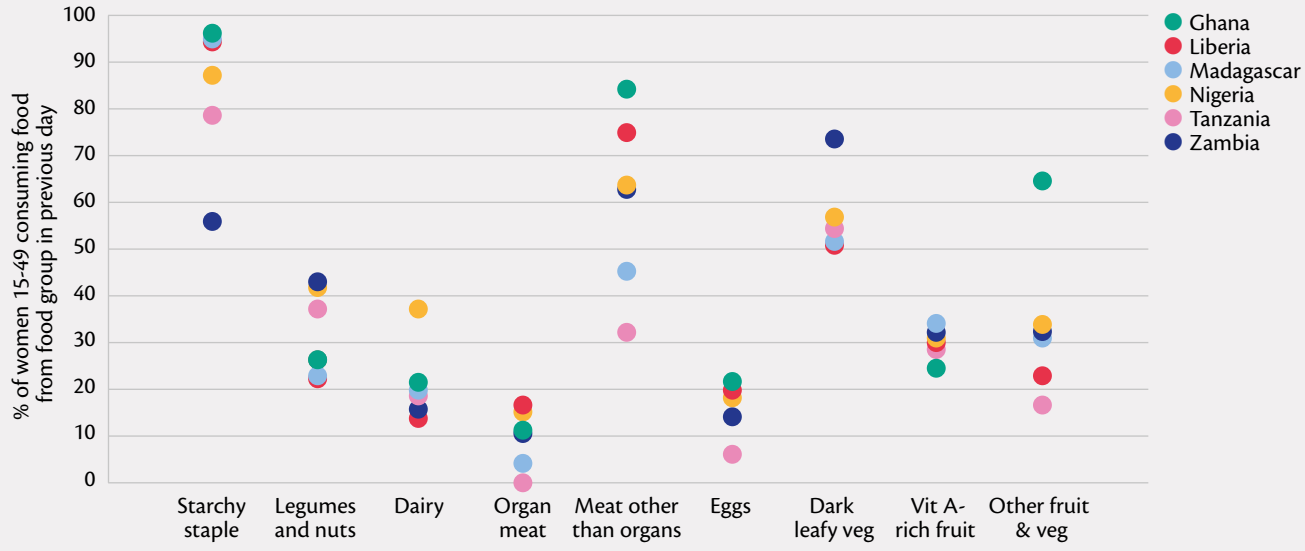
"Cereal-based diets, with low consumption of nutrient-dense foods, characterize intakes across regions".

Mothers of reproductive age

Maternal nutrition is closely tracked because of the nutritional demands of pregnancy on women and because of the consequences of poor maternal nutrition on their newborn children.[77] However, few countries collect internationally comparable data on the quality of women's diet. What we have are from nationally representative surveys (Demographic and Health Surveys) in a small number of sub-Saharan African countries. Using this data, Figure 3.5 shows that most women report consumption of starchy staples, but less than half of women – for all six countries – consumed legumes and nuts, vitamin A-rich fruits and vegetables, dairy or eggs in the preceding day.

Using these same data, analysis[78] shows that higher socio-economic status was associated with higher dietary diversity for women, with an increased intake in the number of food groups consumed and more frequent consumption of fruits, vegetables and ASF (i.e. meat, dairy and eggs). Interestingly, obese women, compared to thin women, had a greater amount of dietary diversity, with particular increases in fruits and vegetables and animal-based foods. As already noted, rising incomes may simultaneously facilitate access to more diverse and nutrient-rich foods, as well as more energy-dense diets. This trend has also been reported elsewhere.[79]

FIGURE 3.5: Percentage of women aged 15-49 years who gave birth in the last three years who consumed various food groups in the day or night preceding the survey, DHS surveys 2007-2010



Source: Kothari et al. (2014), Table 2.10

Note: Year of data; Ghana 2008, Liberia 2007, Madagascar 2008–9, Nigeria 2008, Tanzania 2010, Zambia 2007.

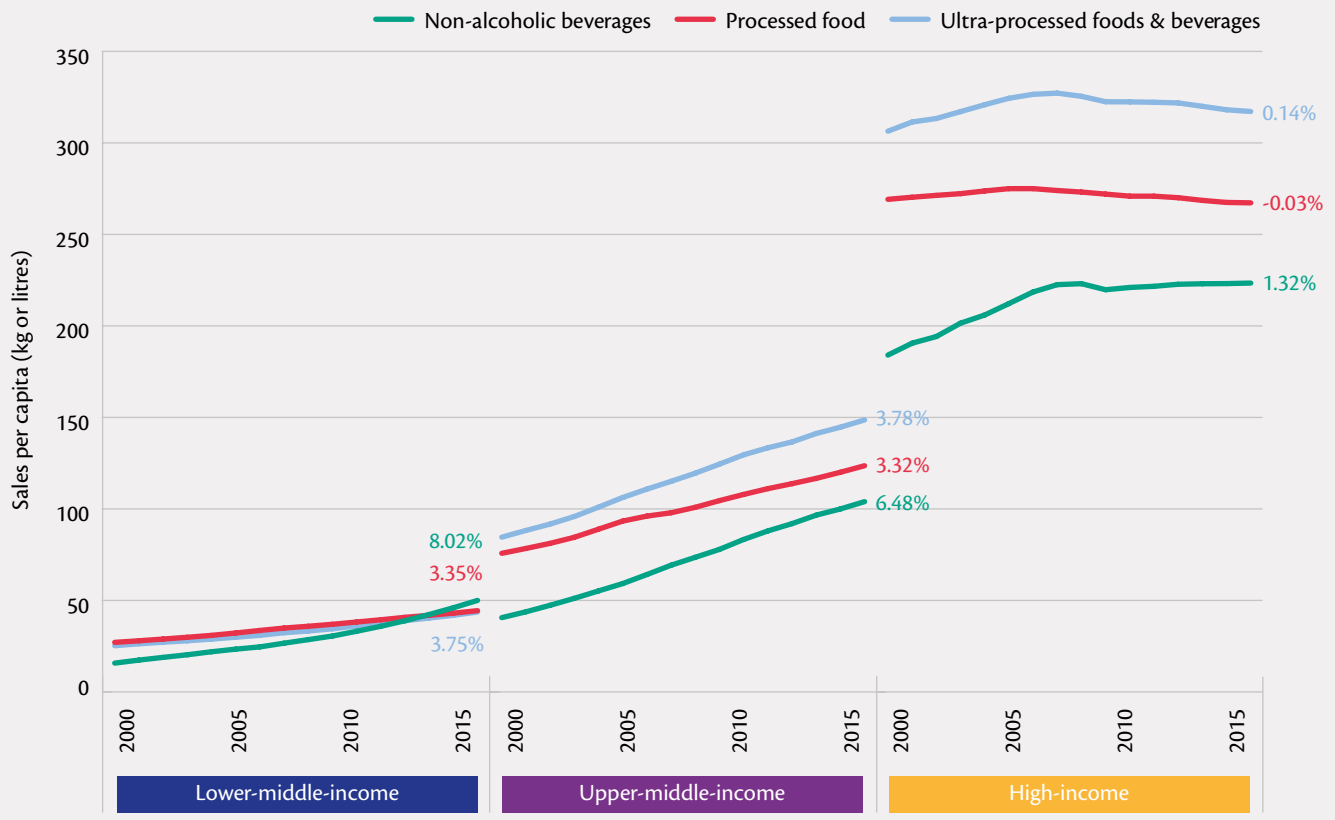
[76]Elliot et al. (2015) [77]Black et al. (2013) [78]Kothari et al. (2014) [79]Mayén et al. (2014); Imamura et al. (2015)

3.3 Purchases of processed foods

Growth of sales of processed foods, including ultra-processed foods, is shown on Figure 3.6. (The definition of what we include in the ultra-processed food category is shown in Table 3 in Appendix 4.) The purchases of food do not equate to actual intake, but still provide a useful proxy measure of how diets are changing. Data on the sales of processed foods are collected from formal retailers by the market analysis firm, Euromonitor. The key limitation of this data source is that no data are available for low-income countries, only for those in the middle- (lower and upper) and high-income categories.

As Figure 3.6 shows, sales in high-income countries have levelled off for all three categories of processed food, although per capita volumes remain high. In contrast, sales have grown rapidly in lower-middle-income countries and upper-middle-income countries and are catching up with the high-income countries. For example, in 2000, sales of ultra-processed foods and beverages in the upper-middle-income countries were one-third of those in the high-income countries. Fifteen years later, they were more than half.

FIGURE 3.6: Trends in per capita sales volumes of non-alcoholic beverages, processed foods and ultra-processed foods by country income group, 2000–15, with 15-year average growth rates shown



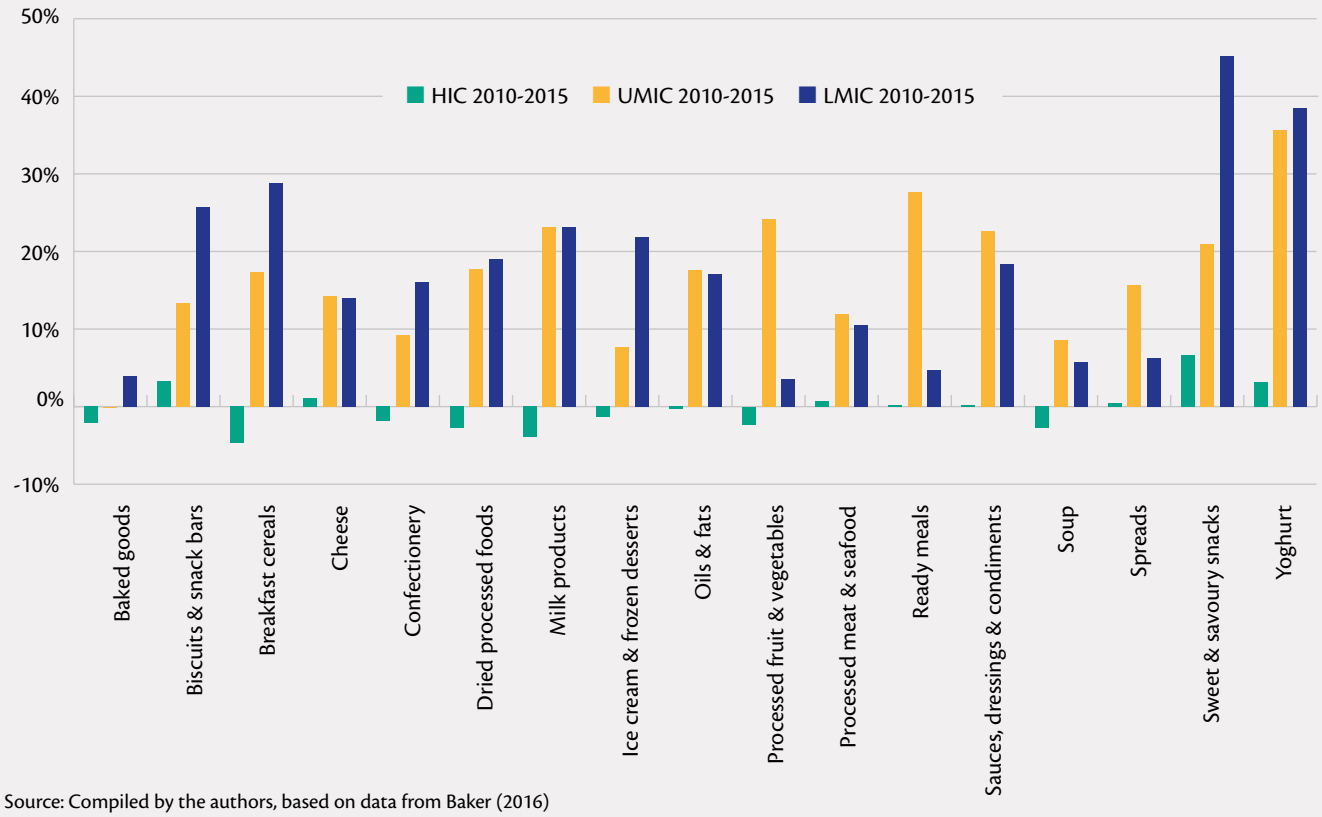
Source: Baker (2016)

In 2000, sales of ultra-processed foods and beverages in the upper-middle-income countries were one-third of those in the high-income countries. Fifteen years later, they were more than half.

In low- and middle-income countries, more than half of the young women and adolescent girls surveyed do not meet their micronutrient needs.

The sales of most processed foods in the high-income countries have plateaued. Growth is visible in nearly all of the middle-income countries (Figure 3.7). The lower-middle-income countries are showing the fastest growth in sales for processed foods that contribute calories, sugars, salt and fats, but little in the form of fruits and vegetables, legumes and wholegrains and micronutrients, i.e. biscuits and snack bars, confectionery, ice cream and frozen desserts, and sweet and savoury snacks. Upper-middle-income countries show the greatest growth in the products that are easier to classify as part of a high-quality diet, i.e. processed fruits and vegetables.

FIGURE 3.7: Total change (percentage) in sales of processed foods (kg/capita per year), by country income group, 2010–15



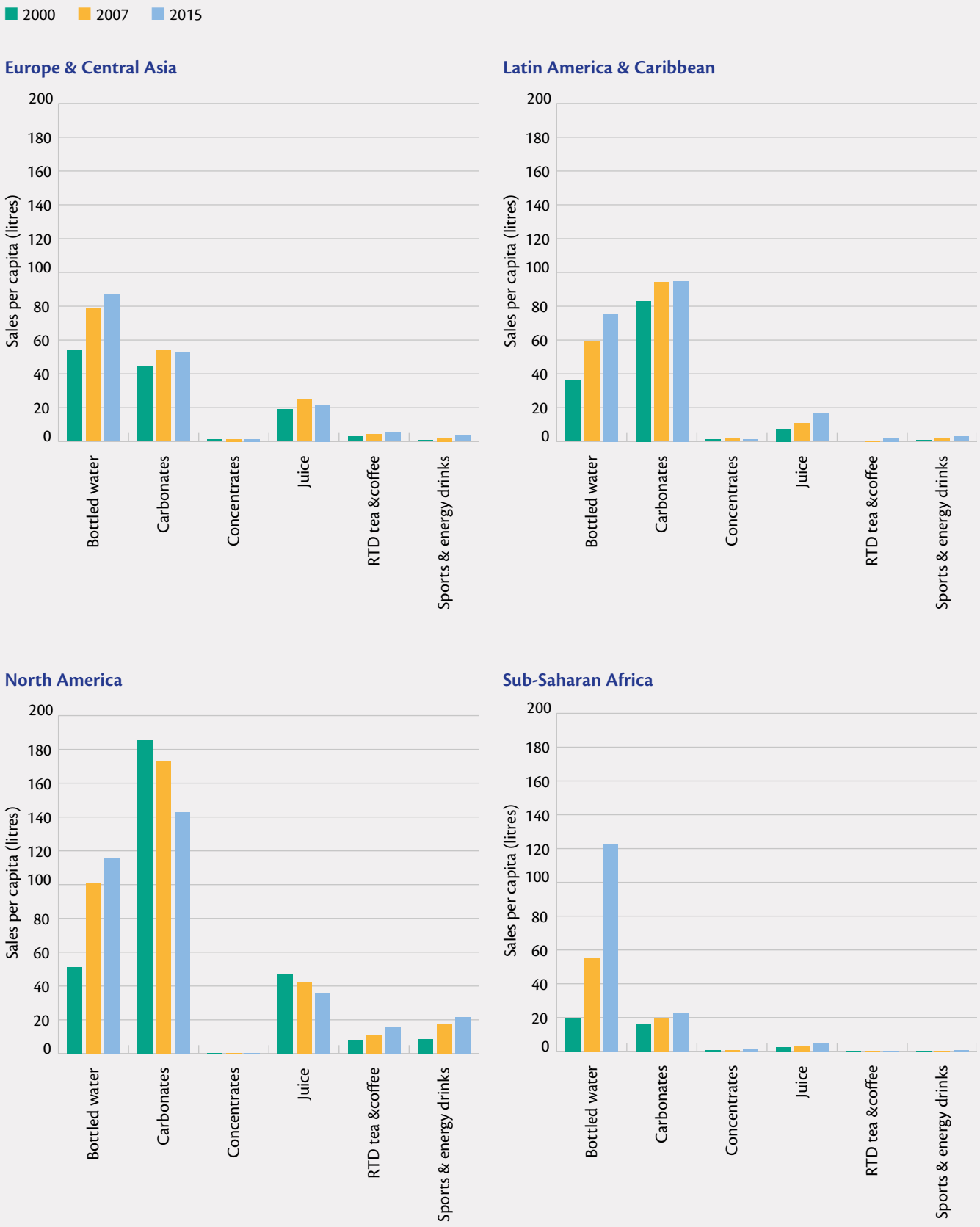
Source: Compiled by the authors, based on data from Baker (2016)

Note: HIC: High-income countries; UMIC: Upper-middle-income countries; LMIC: Lower-middle-income countries.

Figure 3.8 shows the data for the non-alcoholic beverage category (defined in Table 3.3, Appendix 4), which includes carbonated soft drinks, concentrates, ready-to-drink coffee and tea, juice drinks and sports and energy drinks. It shows that sales of bottled water are increasing in every region. Sales of carbonated drinks are rising in Africa, Asia, the Pacific and the Middle East. Juices and ready-to-drink sweetened tea and coffee sales are also increasing strongly in East Asia and the Pacific.

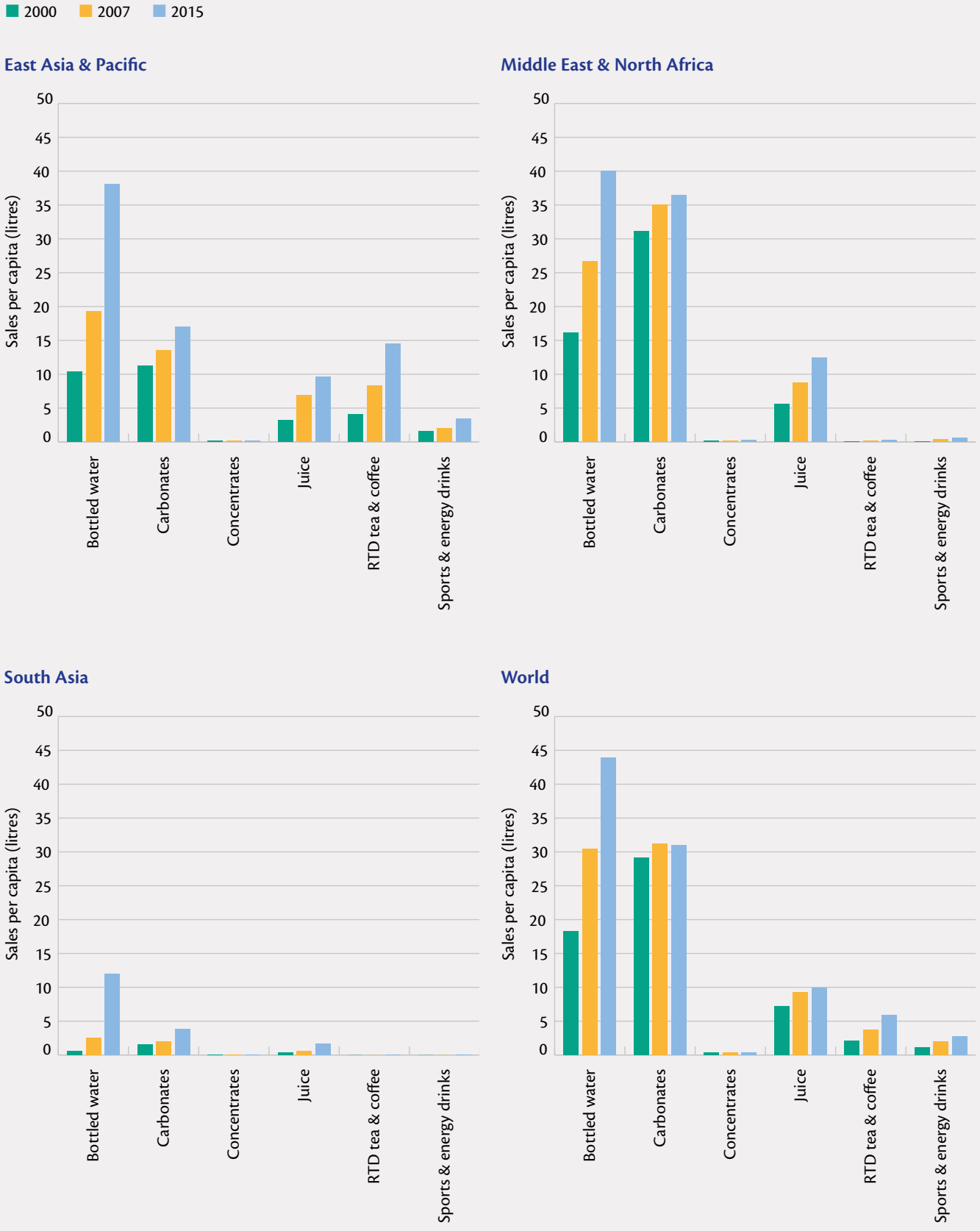
The lower-middle-income countries are showing the fastest growth in sales for processed foods that contribute calories, sugars, salt and fats, but little in the form of fruits and vegetables, legumes, wholegrains and micronutrients.

FIGURE 3.8: Per capita sales volumes of non-alcoholic beverage categories by region, 2000–15



Source: Baker (2016)

FIGURE 3.8 (continued): Per capita sales volumes of non-alcoholic beverage categories by region, 2000–15



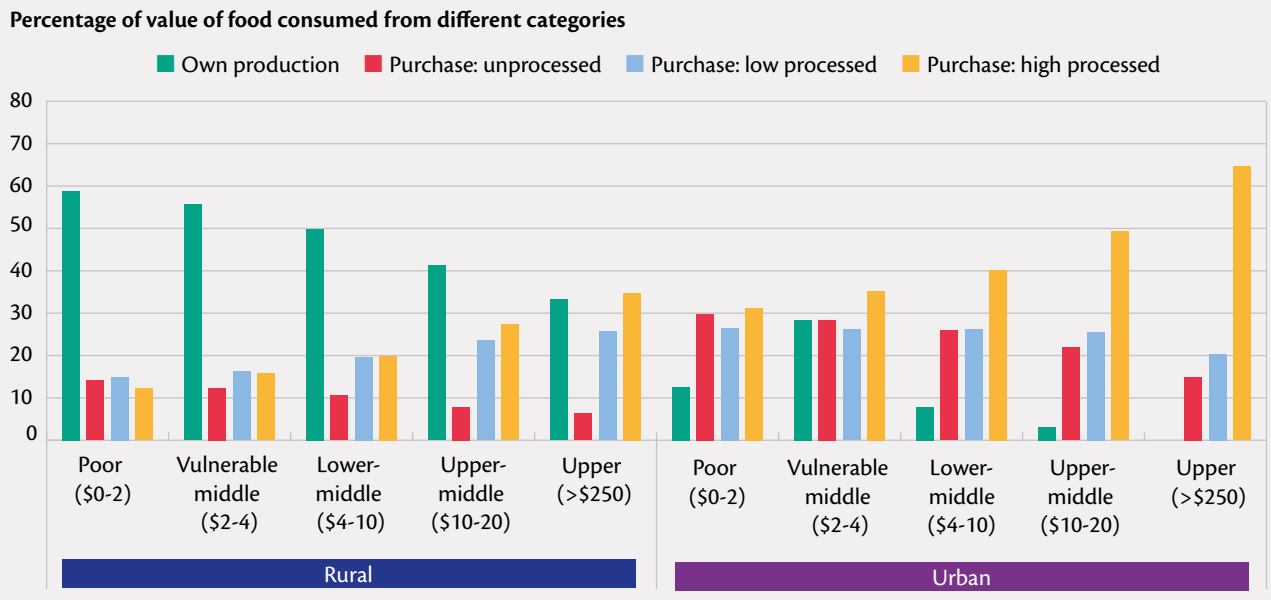
Source: Baker (2016)

Much of the recent growth over the 2000–15 period in ultra-processed foods and beverages in lower-middle-income countries and upper-middle-income countries can be explained by the East Asia and Pacific and South Asia regions,[80] which together are home to four of the world's six most populous countries (i.e. China, India, Indonesia and Pakistan). Much of the stagnant growth in high-income countries has occurred in North America.[81] But Africa, the region where hunger and chronic undernutrition are declining least rapidly, is also experiencing a rapid increase in the consumption of 'highly processed foods' (Box 3.2).

Box 3.2: The rise of highly processed foods in Southern and Eastern Africa

A recent study makes a unique contribution to how diets are changing in Africa by pooling survey data from six African countries to explore the consumption patterns of different income groups in rural and urban areas (see Figure 3.9). It shows that as incomes rise, highly processed foods take an increasing share of the food basket value; this is true for rural as well as urban settings. In urban areas, in the highest income group, highly processed foods take 65% of the value of the food basket compared to 35% for this group in rural areas. The diets of the poorest households in urban areas are also a concern as they spend 31% of their food basket on highly processed foods.

FIGURE 3.9: Percentage of monetary value of food consumed from different categories: Ethiopia 2004/2005, Uganda 2009/2010, Tanzania 2010/2011, Mozambique 2008/2009, Malawi 2001/2011, South Africa 2010



Source: Compiled by the authors, based on data in Tschirley et al. (2015)

In urban areas of Southern and Eastern Africa, in the highest income group, highly processed foods take 65% of the value of the food basket compared to 35% for this group in rural areas.

[80]Baker (2016) [81]Popkin and Slining (2013); Gómez and Ricketts (2013)

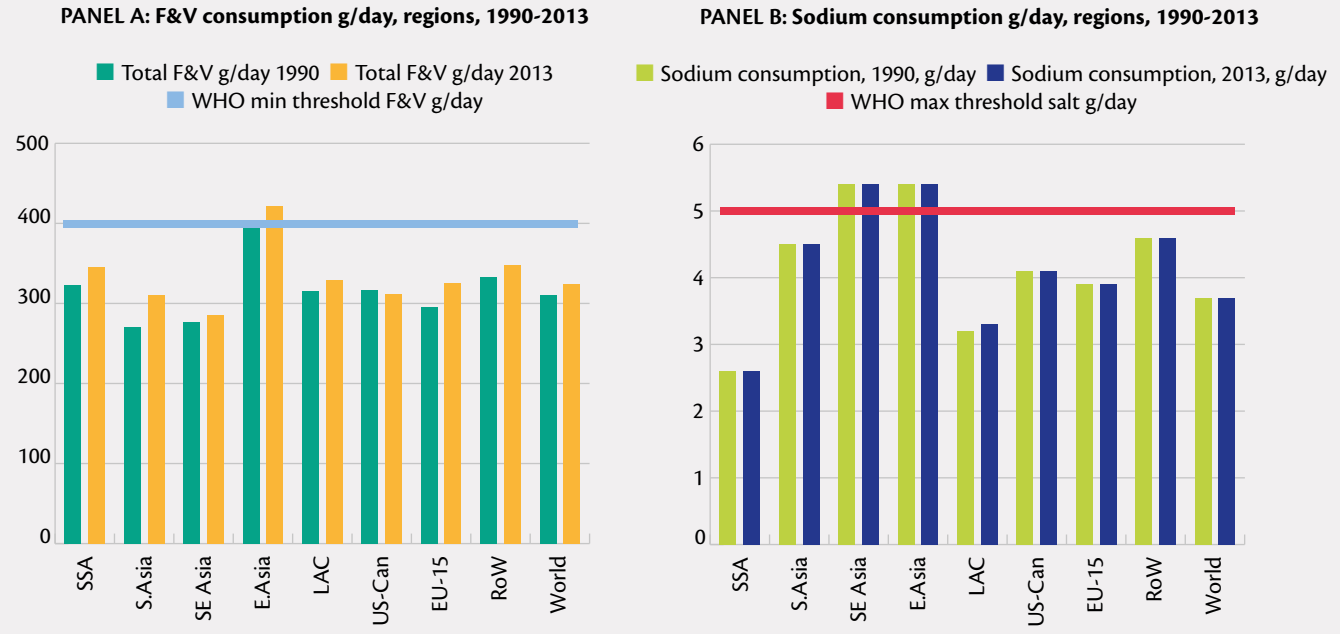
3.4 Implications

The data reviewed in this chapter represent the most complete internationally diet data available. We have brought together disparate data to provide a picture of recent trends in diets around the world. But the data are imperfect – they are highly fragmented across methods and surveys, and partial in coverage of foods and countries.

We conclude that huge numbers of people worldwide have diets that are not of high quality. Box 3.3 summarizes the diet data we presented in the context of what is recommended for a high-quality diet (Chapter 2). It shows a vast gap between what people could be eating to address malnutrition in all its forms, ill health and premature mortality. Infants are not being breastfed as formula sales soar; young children, adolescents and women are existing on monotonous, starch based-diets with little diversity and inadequate animal source foods, increasingly supplemented by ultra-processed foods, while others consume too much red meat, saturated and trans fats, soda and ultra-processed foods and soft drinks. Although fruit intake has been increasing, people are still not consuming sufficient amounts, while vegetable intake is declining.

By way of example, an analysis of dietary intakes of fruits and vegetables, and salt shows that South and South-East Asian countries exceed the minimum WHO recommended levels of fruit and vegetable consumption but also exceed the maximum WHO recommended consumption of salt/sodium (see Figure 3.10, Box 2.1). Higher-income countries such as the United States, Canada and European countries, despite their wealth, are not reaching the recommended levels of fruit and vegetable consumption. In fact their fruit and vegetable consumption is below the average found in sub-Saharan Africa.

FIGURE 3.10: Consumption of (A) fruits and vegetables (F&V) and (B) sodium in relation to WHO recommended levels



Source: Compiled by the authors, based on data in Masters (2016)

Note: SSA: sub-Saharan Africa; S. Asia: South Asia; SE Asia: South-East Asia; E. Asia: East Asia; LAC: Latin America and the Caribbean; US-Can: USA and Canada; EU-15: European Union 15; RoW: rest of world – includes Oceania, the Middle East and other areas outside the specified regions.

Box 3.3: A summary of diet data

Infants and young children

- Based on data from over 100 low- and middle-income countries, less than half of all babies from 0–6 months of age are meeting WHO recommended practice of being exclusively breastfed. Breast milk is the optimal food for children in this age group.
- A small proportion of infants and young children from low- and middle-income countries – at the median of a set of approximately 60 countries with data – are meeting minimum WHO recommended dietary standards.

Women and adolescent girls

- A systematic review of 85 studies from low- and middle-income countries found that the diets of more than half of the young women and adolescent girls surveyed did not meet their micronutrient needs.

All individuals in a population

- **Fruit and vegetable** consumption is below WHO recommended levels in every region except East Asia (Figure 3.10A).
- **Salt/sodium** consumption of salt is above WHO recommended levels in East Asia and South-East Asia (Figure 3.10B).
- **Vegetable consumption** is lowest in South-East Asia and the EU-15 (at almost identical levels). Unlike fruit, vegetable consumption has declined in several regions in the period 1990–2013, including SE Asia, North America and LAC and also declines as national incomes rise.
- **Fruit consumption** is generally increasing over time and by country income group, but levels are highly variable. For example, more than 60% of women surveyed in six African countries report not consuming any fruits and vegetables rich in vitamin A in the previous 24 hours.
- **Red meat consumption** levels are currently low in sub-Saharan Africa and South Asia, but consumption in these regions actually decreased from 1990 to 2013. Red meat consumption has increased substantially in East Asia and is now at levels seen in the USA and Canada. In general as national income rises, more red meat is consumed.
- **Sugar-sweetened beverage** (SSB) consumption levels are much higher in North America, Latin America and the Caribbean than in any other region, and in North America they increased substantially between 1990 and 2013. The upper-middle-income countries are where consumption of SSBs is growing most rapidly.
- **Processed meat consumption** is increasing in every region: in SE Asia, Latin America and North America, intakes have increased by approximately 40% over the past two decades.
- **Trans fat consumption** is highest in South Asia and is declining only slowly there.
- **Ultra-processed food purchases** have levelled off in the high-income countries, but are growing rapidly in low-middle-income countries and in upper-middle-income countries (and in upper-middle-income countries from a much higher level). In the poorest urban populations surveyed in six African countries, 31% of the basket value of food is going to highly processed foods. In the upper-income group in urban areas, the share is as high as 65%.

Source: Compiled by the authors

While the consumption of recommended components of diet is increasing worldwide, the consumption of less healthy diet components is also increasing. This includes, in particular, growth in the consumption of ultra-processed foods. The team that helped to compile the Global Dietary Database and have analyzed it for its health consequences[82] conclude that the quality of the diets – from a disease perspective – actually declines as national income rises. While this assertion requires more analysis before being fully accepted, we note that high-income country populations consume high levels of foods that are good for health but also foods that are not.

Thus, the low- and middle-income countries of today do not have to follow the nutritionally damaging path that high-income countries have taken: diets low in calories and micronutrients can be addressed without increasing consumption of salt, added sugars and harmful fats beyond recommended levels. Policy makers need to find more direct and less damaging dietary pathways from where their countries are to where they want to be. Chapters 7 and 8 provide advice and guidance on how policy makers can achieve this.

[82]Imamura et al. (2015)

4 Forecasting changes in food availability

KEY MESSAGES

- A continuation of current trends in food availability will not deliver the diets needed to accelerate hunger reduction or reduce the growth in obesity.
- Vegetable production is projected to rise much less rapidly than fruit production. For vegetable availability to meet recommended levels, there will need to be a strong drive to action across policy, research, technology and infrastructure.
- Forecasts on the availability of meat, fish and dairy suggest robust growth in demand from middle-income countries but less in low-income countries where availability needs to be accelerated. While in middle-income countries, ways need to be found to slow down increases in availability once upper limits consistent with good health are in sight.
- The numbers of people with obesity are growing exponentially in the developing world and show no signs of slowing down. For example, by 2030, sub-Saharan Africa's rate of overweight and obesity is expected to reach 17.5%, double that of 2005.
- If current trends continue, the health and economic costs will be large. The developing world could avert four million deaths per year by 2050 if the consumption of fruits, vegetables and red meat – as well as total calorie availability – is brought in line with recommended levels.
- Different regions and countries need to focus policy on particular dimensions of diets to reap health benefits. For example, for Brazil, China and the Philippines, the greatest projected benefit is from reducing red meat availability.

4 Forecasting changes in food availability

The available data tell us that while diet quality is improving among some groups of people, overall the negative trends are dominant. How might we expect them to develop over the next two decades? In this chapter, we consider what people might be eating in low- and middle-income countries up to 2035. The analysis of future food consumption is a difficult task for two reasons. First, given limitations in the available data and existing models, it is not possible to forecast diets directly. Second, the myriad of factors that can affect diet quality directly and indirectly develop very differently in specific situations and localities so detailed and finer-grained analysis is necessary at local levels. Nevertheless, there is a range of useful measures associated with diet quality for which predictions can be made. Therefore, we use a variety of approaches to achieve this, as explained more fully in each subsequent section.

4.1 Calorie adequacy

Here we report on FAO projections of undernourishment based on total calorie availability. The measures are useful to assess the role of adequacy as a critical dimension of diet quality for many countries.

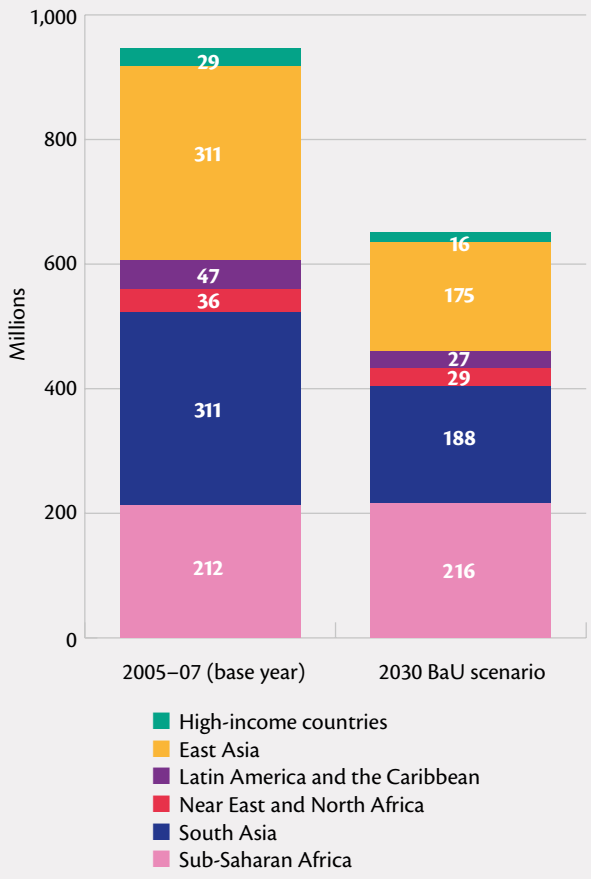
While most of major world regions met the Millennium Development Goal for hunger in 2015,[83] business as usual (BaU) estimates[84] (shown in Figure 4.1) suggest that by 2030, there will still be 653 million calorie-deficient people. This is down from 795 million in 2015. Most of the reductions in calorie insufficiency will come from Asia, while Africa will see a levelling off. If nothing is done, Asia and Africa will still be grappling with significant hunger in the next 15 years.

Estimates suggest that if investment of US$117 billion were made in rural areas over the next 15 years (which is additional to a social protection transfer of US$19 billion), this would be sufficient to get to zero hunger in sub-Saharan Africa.[85] Although the US$117 billion is not driven by nutrition considerations, much of it offers great opportunities for improving the quality of diet as well as the quantity. For example, approximately 40% of the investment is slated for roads and energy infrastructure, vital for building effective cold chains for fresh foods, while 10% is for agro-processing and 12% is for research and development (R&D), and extension.

Refocusing these investments through a diet quality lens would enable these large public and private flows to deliver diets higher in diversity (and hence micronutrients), without trade-offs in hunger reduction.

If nothing is done, Asia and Africa will still be grappling with significant hunger in the next 15 years.

Figure 4.1: Undernourishment in the base year and projections to 2030 in the business-as-usual (BaU) scenario, FAO



Source: Compiled by the authors, based on data in FAO, IFAD and WFP (2015a), Table 1 .

Notes: (1) the total undernourished in the base year of 2005–7 is 949 million, (2) BaU scenario: In the various regions, GDP is projected to increase at rates between 2.0% (in Latin America and the Caribbean) and 4.5% in East Asia (Table 2). The population in the five regions is expected to grow by an annual average of 1.1% between the baseline period and 2030.

[83]FAO, IFAD and WFP (2015b) [84]FAO, IFAD and WFP (2015a) [85]FAO, IFAD and WFP (2015a)

4.2 Food availability

Available calories come from different foods and this is an important measure of diet diversity, which, as shown in Chapter 2, is a critical component of diet quality. Here we draw on FAO projections to 2030 on food availability.[86] The projections show significant changes over time for a number of foods in different regions. In Figures 4.2–4.4, the bars above the line show growth in calorie availability per capita from each food, while those below the line show a decline. Note that the Food Balance Sheet data from FAO do not permit a separation for each of these categories into processed and unprocessed foods.

FIGURE 4.2: Growth in per capita daily caloric intake (2005/2007-2030): Low- and middle-income countries and high-income countries

Source: FAO Global Perspectives Studies Team, unpublished data

Notes: The commodity and country aggregation follows Alexandratos and Bruinsma (2012).

Overall, projected per capita growth rates are much higher in developing than developed countries (Figure 4.2). These increases have many implications for diet quality. For ASF, growth in availability will be particularly high in the developing world; poultry, beef and dairy will all grow rapidly. ASF have a complex profile with respect to nutrition (Box 4.1). They provide essential micronutrients in a highly digestible form, which is of particular nutritional value in pregnancy and early childhood. At the same time, certain ASF, such as processed meats and red meat (above a certain level), are less healthy.

[86] Alexandratos and Bruinsma (2012)

Box 4.1: Animal source foods (ASF): The challenge of hitting the healthy range[87]

Globally, in recent decades there has been a large increase in the production of poultry and dairy, while growth in red meat (from ruminants such as cows and sheep) has been slower (mainly driven by static levels in the developed world). For fish, there has been a shift from wild-caught to farmed fish, which now accounts for half of world production. These shifts have been associated with higher productivity, as the capacity of chickens and fish to convert feed (largely from grain crops) into meat is far better than for ruminants. At the same time, much animal production takes place on ever-larger farms, with many livestock housed in stall-fed systems, reliant on water and feed brought in from elsewhere, generating heavy environmental and animal welfare costs, such as greenhouse gas emissions and nitrate pollution from slurry. International trade in ASF has grown rapidly as well, with middle-income countries now becoming major importers and exporters. These trends in production and trade have made ASF more available in the developing world.

But the trends in availability are not linear. FAO finds an S-shaped relationship between increased incomes and increased demand for ASF.[88] In other words, at a certain income in the middle-income range, demand rises rapidly. Hence middle-income countries run the risk of "overshooting" the ASF healthy consumption range. Low-income countries are projected to struggle to increase ASF consumption to the levels needed to address micronutrient deficiencies. So the challenge for low-income country policy makers is to increase consumption of ASF (excluding processed meats and being mindful of excess red meat consumption levels). In middle-income countries, policy makers have to find ways of putting the brakes on consumption before levels overshoot the healthy range.

Source: Compiled by the authors

Figure 4.2 shows that cereal availability will experience a lower level of growth, except for barley, most of which will be used in beer production. While the availability of certain fruits, such as citrus and bananas is projected to grow rapidly, the projected growth in the availability of vegetables and pulses – both important for diet quality – is low. It will require a concerted effort to change the trajectory of vegetable availability (Box 4.2). The availability of vegetable oil will grow rapidly in the developing world with health effects dependent on the type of oil that is growing most rapidly (e.g. palm oil is less healthy than olive oil).

Box 4.2: Fruits and vegetables: Shifting the projections[89]

Chapter 3 showed that in almost all parts of the world, current consumption of fruits and vegetables is below WHO recommended levels. It is clear from Figure 4.2 that this picture, at least for vegetables, will not have changed much by 2035 unless something happens to accelerate current trends. What might that be?

Fresh fruits and vegetables are challenging to produce and distribute. They are susceptible to temperature extremes during production and are highly perishable and so need to be brought to market in an unbroken cold chain or processed (dried, canned, pickled etc.) rapidly.[90] Technological innovation has considerable potential to improve fruit and vegetable availability. But, as Chapter 6 will show, public research and development investments in vegetable breeding for low- and middle-income countries have lagged far behind that of staple crops.

As we shall see in Chapter 8, public policy can incentivize greater investment in the infrastructure required to produce, store and transport fruits and vegetables, for example via the reform of consumer food price subsidy policies which currently tend to focus on staple crops. These public sector incentives would provide additional impetus for improvements in commercial production, such as higher-quality seeds and more efficient and lower cost shadehouses and greenhouses,[91] extending growing seasons and areas.[92] Technology developments in tracking transportation, processing and storage technologies[93] may also improve availability.

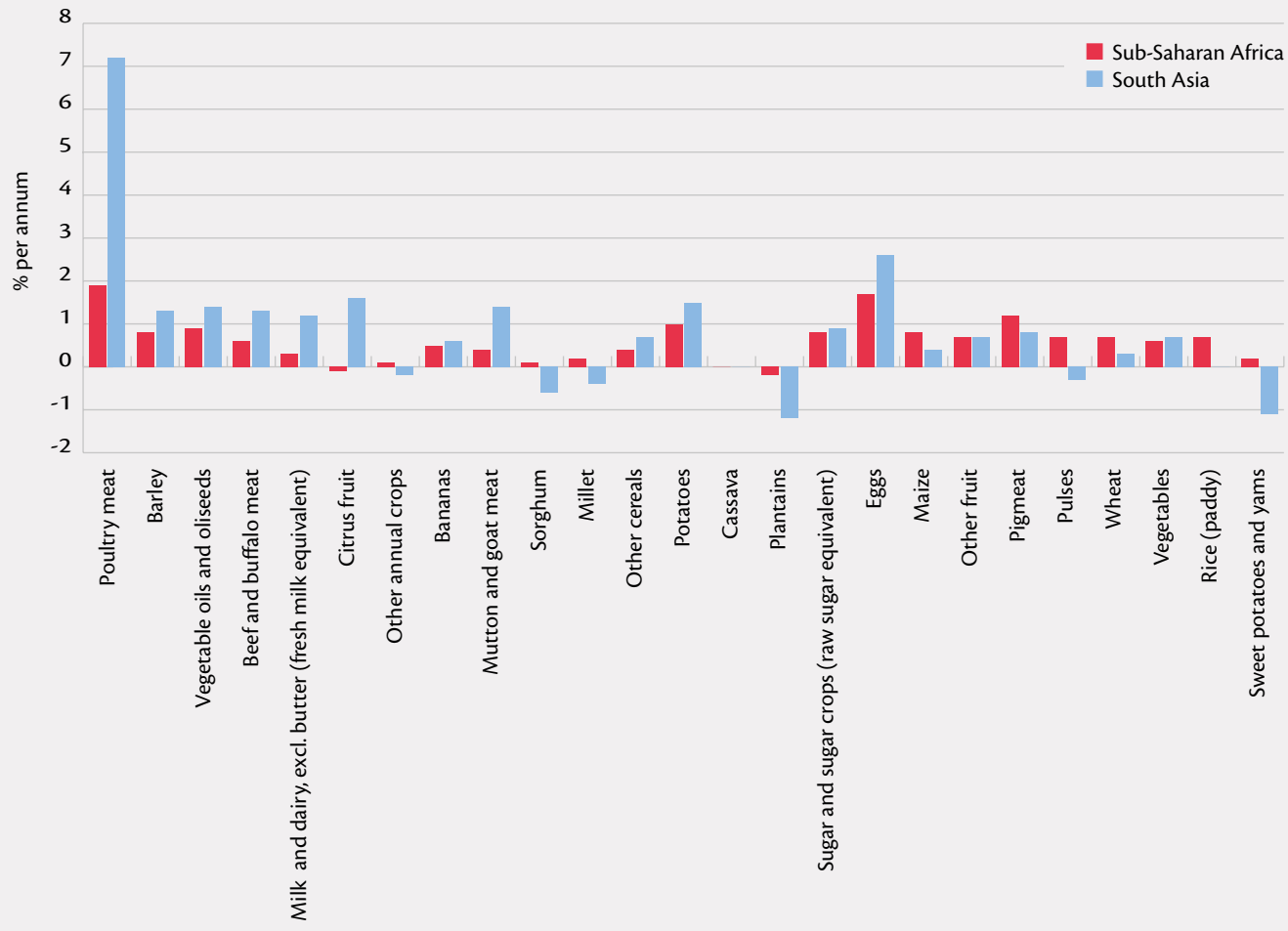
Source: Compiled by the authors

[87]Garnett (2016) [88]Alexandratos and Bruinsma (2012) [89]Meade et al. (2016) [90]FAO (2016a) [91]Brown-Paul (2014) [92]Siegel et al. (2014) [93]Ruiz-Garcia et al. (2009); Samadi (2014); Luo et al. (2016)

Figures 4.3 and 4.4 reveal substantial differences in the projected rates of change in availability for countries in four different regions. In sub-Saharan Africa, growth rates in availability will be below 1% for most commodities except for a range of ASF (such as poultry, eggs and pig meat), while in South Asia, growth rates will be higher, particularly for poultry meat availability (Figure 4.3).

In the wealthier countries of East Asia, growth rates will be highest for ASF, fruits and vegetable oils (Figure 4.4). In all four regions, growth rates for vegetables and pulse availabilities will be amongst the lowest.

FIGURE 4.3: Growth in per capita daily caloric intake (2005/2007-2030): Sub-Saharan Africa and South Asia

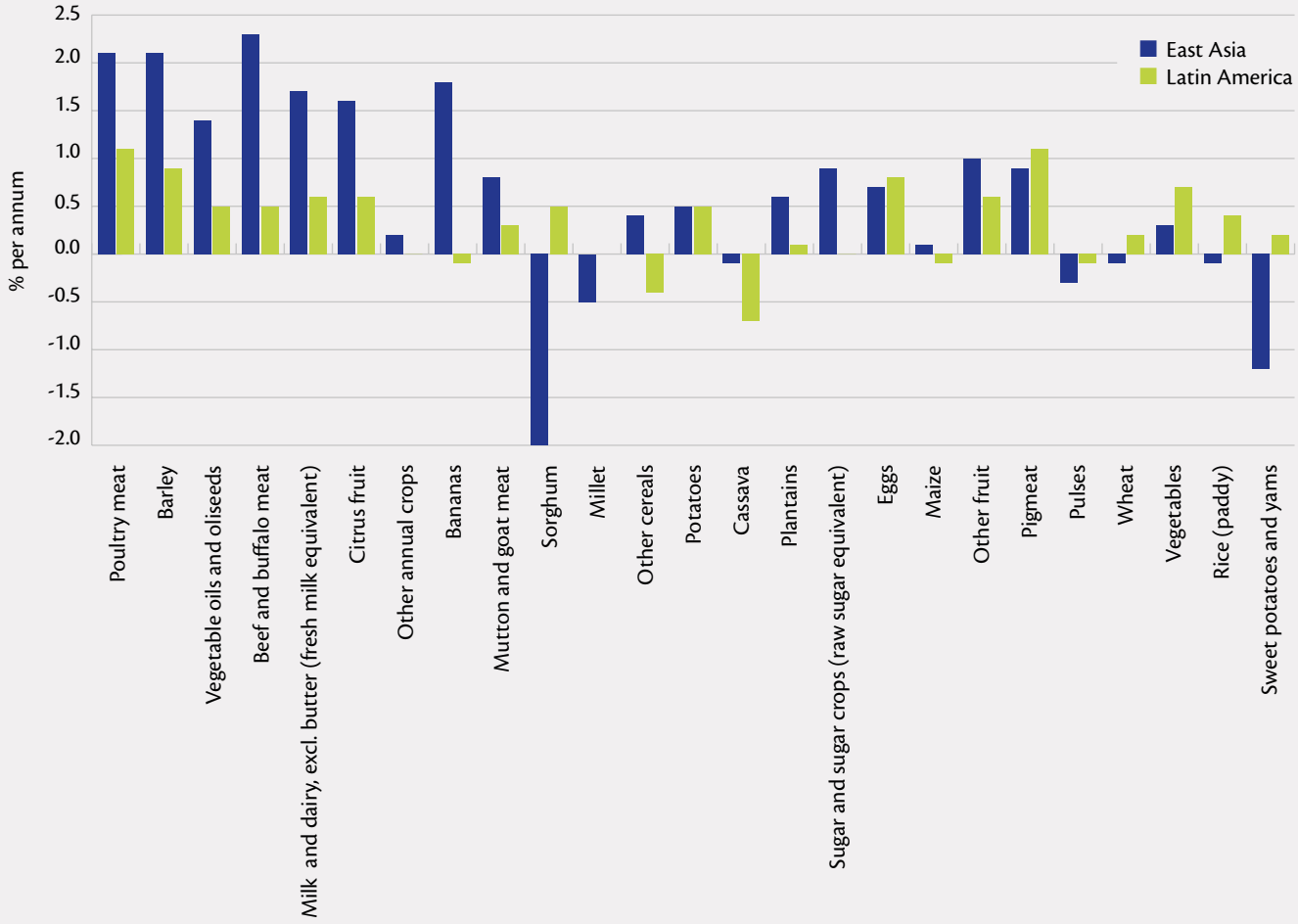


Source: FAO Global Perspectives Studies Team, unpublished data

Notes: The commodity and country aggregation follows Alexandratos and Bruinsma (2012).

A continuation of current trends will not deliver the high-quality diets needed to accelerate hunger reduction or reduce the growth in obesity rates.

FIGURE 4.4: Growth in per capita daily caloric intake (2005/2007-2030): East Asia and Latin America



Source: FAO Global Perspectives Studies Team, unpublished data

Notes: The commodity and country aggregation follows Alexandratos and Bruinsma (2012).

Accounting for population growth, the obesity prevalence for sub-Saharan Africa will be 17.5% in 2030– a doubling of the figure in 2005.

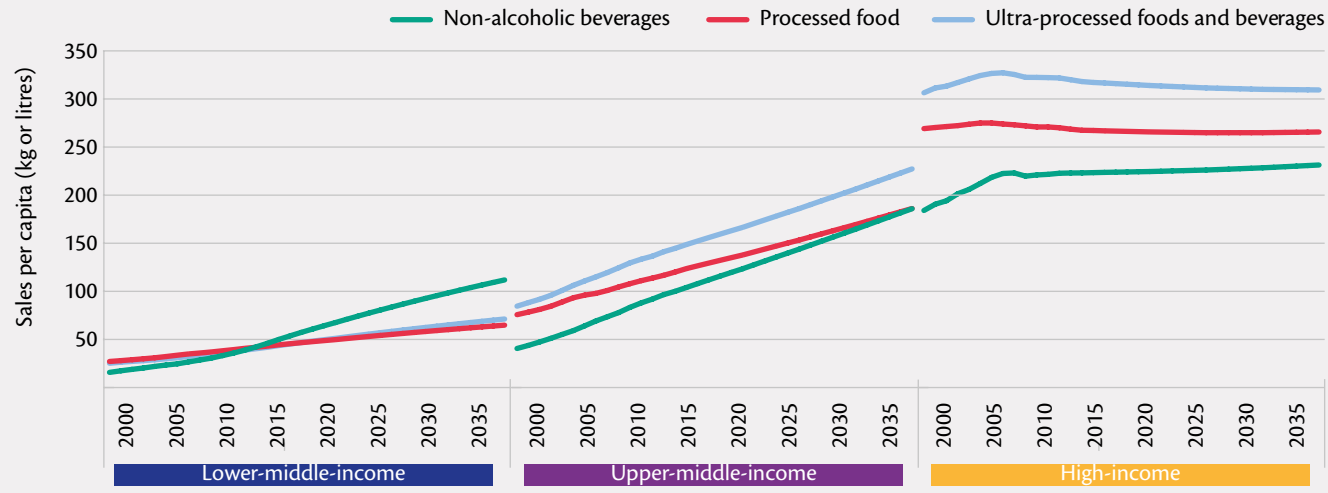
The developing world will avert four million deaths per year by 2050 by bringing the consumption of fruits and vegetables and red meat in line with recommended levels.

4.3 Sales of ultra-processed foods

As we noted in Chapters 2 and 3, the consumption of ultra-processed foods is thought to contribute significantly to overweight and obesity, and levels of consumption of added sugars, saturated and trans fats and salt that are above recommended levels. The largest sales growth has been in the low- and middle-income countries. Figure 4.5 projects these data forward to 2035.[94] The projections suggest that sales of ultra-processed foods will not change substantially in high-income countries, but will grow substantially in lower-middle-income countries and even more rapidly in upper-middle-income countries. In fact, based on current trends, projections in Figure 4.5 show that by 2035, the sales of ultra-processed foods in upper-middle-income countries will reach almost 75% of the levels in high-income countries.

When examined at a regional level (figures not shown here), much of the projected rapid growth in ultra-processed food consumption in lower-middle-income countries and upper-middle-income countries will be in East Asia, including such populous middle-income countries as China and Indonesia, while sales in South Asia and sub-Saharan Africa will grow more slowly and from a lower base.[95]

FIGURE 4.5: Projections of sales per capita of processed foods, non-alcoholic beverages and ultra-processed foods and beverages to 2035 in countries at different levels of income



Source: Baker (2016)

4.4 Health implications of food availability projections

How will these projected changes translate into health impacts? First, obesity rates have already been increasing at an exponential rate in low- and middle-income countries. Figure 4.6 shows this clearly for the period 1980–2015. The change in the number of obese men and women for Africa, Asia and Latin America and the Caribbean is stark.

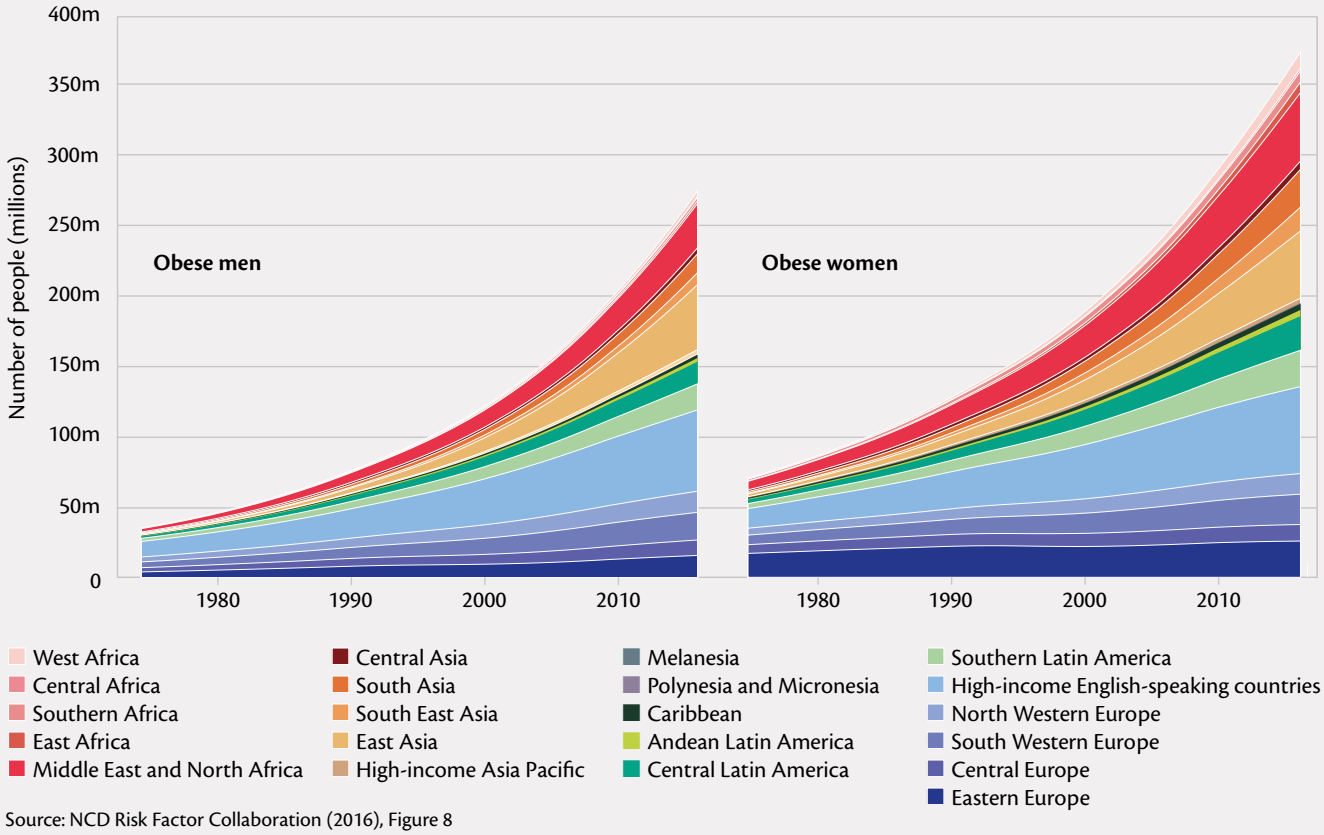
Projections of obesity rates to 2030 are therefore a major concern (see Box 1.1). The number of obese men and women is growing in nearly every region (Figure 4.6). For example, accounting for population growth, estimates suggest that in 2030, the obesity prevalence for sub-Saharan Africa will be 17.5% – a *doubling* of the figure for 2005.[96]

The analysis here and work commissioned for this report[97] shows that a continuation of current trends in food availability and diets is unlikely to slow obesity rates down. Can we put a number on the costs of failing to do so? The best available estimate is from Springmann et al. (2016).[98] They compare FAO 2050 projections[99] of calories available from fruits and

The projections on food purchases are based on projected trends in GDP per capita and the KOF Index of Globalization as a measure of the extent of a country's integration into the global economy. The projections cover 78 countries, representing 82% of the world's population in 2015, but they do not contain any low-income countries (Baker, 2016). [95]Industry-based Euromonitor sales data do not include low-income countries. As the drivers of ultra-processed food and non-alcoholic beverage sales in low-income countries are likely to be similar to those in middle-income countries, it is reasonable to conclude that sales and consumption will also increase in the former towards 2035, but probably at a slower rate and from a lower base than in low-medium-income countries. [96]Kelly et al. (2008) [97]Springmann et al. (2016c) [98]Springmann et al. (2016c) [99]This is the same data series we used in Section 4.2, but which we only projected to 2030.

vegetables, from red meat and the total calorie availability with the corresponding recommended dietary levels from WHO and the World Cancer Research Fund (WCRF)[100] referred to here as the 'dietary guidelines'. They model the effects of moving red meat consumption (down), fruits and vegetable consumption (up) and total calories (down) to recommended levels. They assume that food availability data approximates food intake data. For the developing world, they estimate that the adoption of these three dietary changes would, in 2050, lead to four million deaths avoided.

FIGURE 4.6: Trends in the numbers of men and women affected by obesity: 1980–2010



Source: NCD Risk Factor Collaboration (2016), Figure 8

Figure 4.7 shows the benefits in terms of avoided deaths per million of the population in 2050 of adopting this improved (but still limited[101]) dietary profile: East Asia and Latin America and the Caribbean stand to gain the most from adopting these recommended levels, followed by sub-Saharan Africa.

The projections help to prioritize where the greatest policy effort needs to be placed, at least among these limited number of food-related health risks. For example, for South Asia and sub-Saharan Africa, health gains will be realized mainly through increases in fruit and vegetable consumption, whereas in East Asia, the gain will be from reducing the consumption of red meat because projected levels in 2050 will be well over those recommended levels. In Latin America and the Caribbean, the largest share of health improvement will come from reducing calorie availability per capita.

Figure 4.8 disaggregates the analysis in Figure 4.7 to the country level for a selection of countries. Two things are worth noting. First, on current trends, Brazil will stand to gain more than the US in terms of number of deaths avoided by adopting the dietary guidelines recommended by WHO and WCRF.[102] Similarly, South Africa will stand to gain more than Australia, and Bangladesh will gain more than Japan. This reinforces the extent to which developing country diets, based on current trends, will change over the next 35 years in ways that are not consistent with recommended levels. Second, different countries will need to set different priorities over the next 35 years. For India, Bangladesh and Pakistan, an important challenge is to increase fruit and vegetable consumption beyond currently forecast levels. For China and the Philippines, a key challenge is to bring red meat consumption more in line with recommended levels by 2050.

[100]Full details are given in Springmann et al. (2016). The recommended intakes they apply are as follows: Minimum five portions per day of fruits and vegetables, max 300 g per week of red meat, less than 50 g per day of sugar and total energy intake as recommended for moderately active population (2200–2300 kcal per day).
[101]For example ultra-processed foods are not modelled [102]Full details are given in Springmann et al. (2016a)

4.5 Implications

The overall picture of likely food availability outcomes in 2035 is outlined below.

- Hunger rates will have reduced quite rapidly in Asia but more slowly in sub-Saharan Africa, with absolute numbers barely changing. Hunger will continue to be a serious issue that food systems need to address in 2035. The resources that will be required to end hunger also have the potential to improve dietary diversity.

- The growth of red meat consumption is slowing down, but the consumption of other types of ASF will continue to grow. The growth in ASF will be uneven. It will be slowest in the very places it is needed the most – low-income countries where lack of micronutrients and dietary diversity is a real problem. ASF will increase rapidly in middle-income countries with the risk of an overshoot beyond healthy levels of ASF availability.

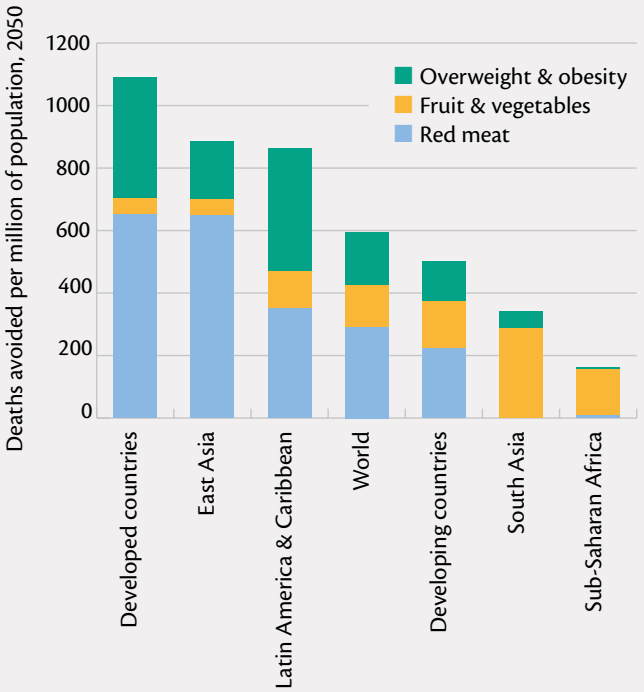
- Fruit and vegetable availability show different global trajectories. Fruits will have achieved a steady growth in availability but growth rates have been lower for vegetables. For vegetable availability to have met recommended levels, there will need to have been a strong push on policy, research, technology and infrastructure.

- Regionally, in East Asia, there are large increases in the availability of meats (all types), fruit, oils, milk and raw sugar but low growth in the availability of vegetables and a decline in pulses. Sub-Saharan Africa and South Asia also show low growth in vegetable availability.

- Sales of ultra-processed foods have increased rapidly in low- and middle-income countries, especially in East and South-East Asia where projected sales levels will approach those for high-income countries by 2035.

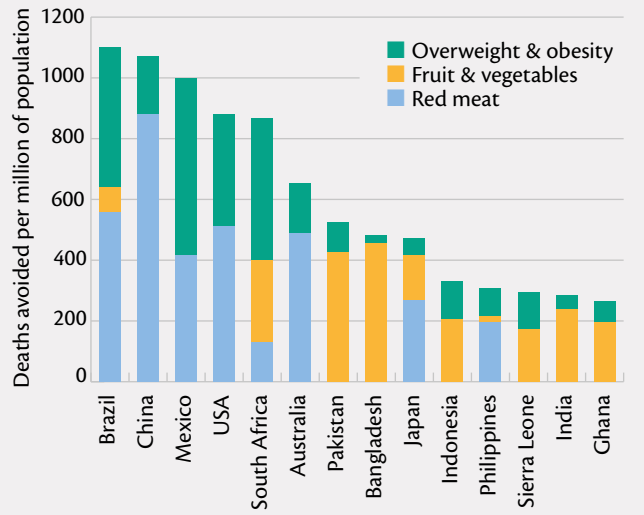
In conclusion, a continuation of current trends will not deliver the high-quality diets needed to accelerate hunger reduction or reduce the growth in rates of overweight and obesity. The drivers of these trends are found both outside and within food systems. Drivers found within food systems will be addressed in Chapter 5. It is the main drivers found outside of food systems–the contextual drivers – that we turn to next: how do they shape diets and food systems and what kinds of diet challenges do they pose?

FIGURE 4.7: Deaths avoided by applying dietary guidelines for fruits and vegetables, red meat and energy intake to food availability data (compared to 2050 FAO projections) by region



Source: Compiled by the authors, based on data in Springmann et al. (2016a), supplementary data

FIGURE 4.8: Deaths avoided by applying dietary guidelines for fruits and vegetables, red meat and energy intake to food availability data (compared to 2050 FAO projections) – selected countries



Source: Compiled by the authors, based on data in Springmann et al. (2016a), supplementary data

Photo: José Morcillo Valenciano

5

Why are diets changing?

KEY MESSAGES

- **Many factors outside the food system have profound implications for diet quality. Important examples include: income growth, changes in the size and structure of populations, urbanization, globalization, climate change and competition for natural resources.**
- **These drivers are interrelated and combinations of them offer both opportunities and threats for the attainment of high-quality diets. There are genuine trade-offs and tensions to be resolved.**
- **The food system is the place where these drivers converge to influence diet and as such, the food system becomes a place where these tensions and trade-offs can be resolved.**

5 Why are diets changing?

In the previous chapter, future projections in food availability and purchases were reviewed, along with the economic costs of continuing with current trends and the benefits of changing them. In the chapters that follow, we consider how these changes might be made. Here, we take a closer look at the role of a number of the most important drivers of diet. In particular, we focus on the role of income growth (including changes in poverty and inequality), urbanization, the policies and processes of globalization, population change, climate change and resource use as drivers of diet change.[103]

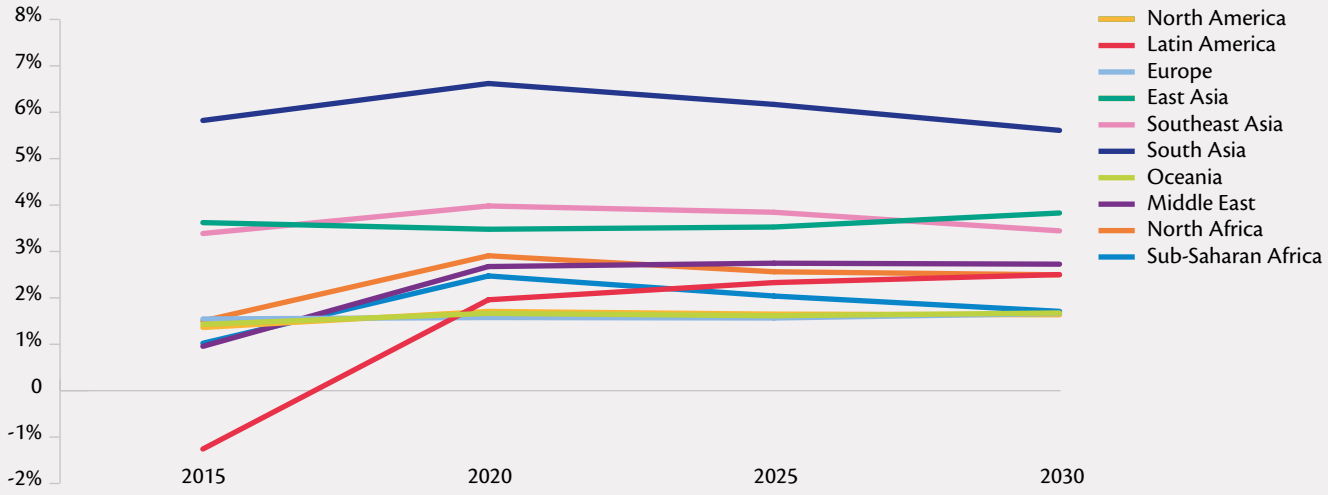
5.1 Income growth

In Chapter 3, we saw that increases in income are accompanied by more diverse dietary patterns which are characterized by a move away from starchy staples such as grains, roots and tubers towards other food groups, greater demand for processed foods to cook at home and more prepared foods bought and consumed away from home. This is the case at household and country levels.[104]

While increased income reduces hunger and improves diet diversity, it is a double-edged sword for diet quality[105] as it also compromises the latter by enabling consumption of excessive calories, ultra-processed foods and excessive consumption of meat. Thus, current trends will mean that while diets will improve in terms of calories and some micronutrients, the balance in the intake of foods that contribute to high-quality diets in only small quantities will tip over into excessive consumption.

Figure 5.1 shows projections to 2030 of annual growth in real per capita GDP. South Asia is expected to be the fastest growing region, followed by East Asia and South-East Asia. Growth in per capita GDP in sub-Saharan Africa is positive, but relatively low compared to Asia. The lower growth in income in sub-Saharan Africa will result in a slow down in the rise in consumption of foods that lower diet quality, but, as discussed in Chapter 3, it will also slow down increases in the consumption of foods that will improve diet quality.

FIGURE 5.1: Projected annual growth rate (%) of real per capita GDP, by region, 2015–30

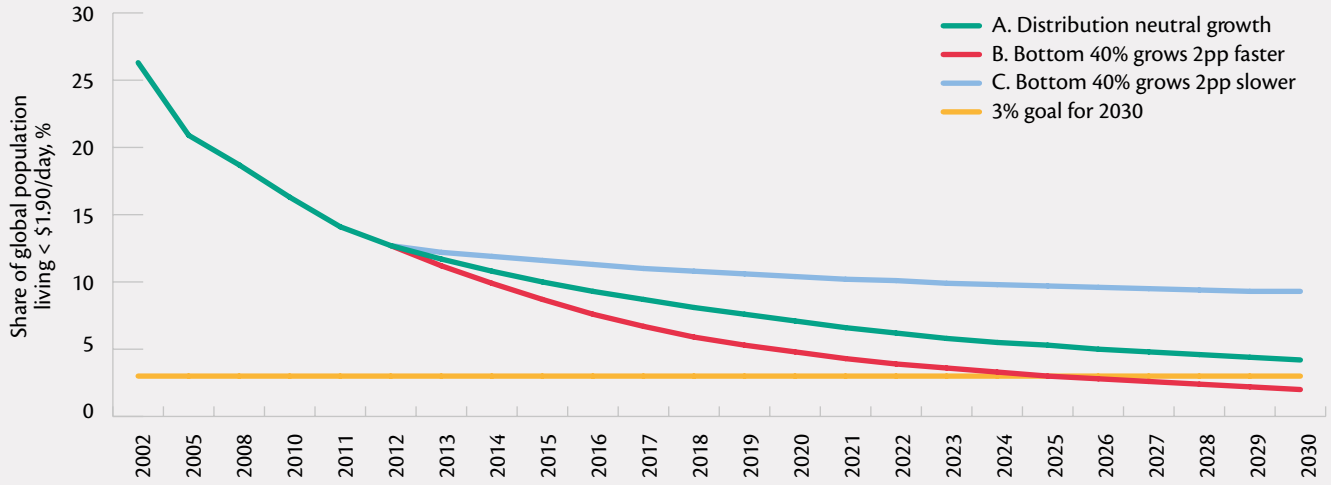


Source: Compiled by the authors, based on data in USDA Economic Research Service (2016), International Macroeconomic Data Set

The effects of income growth on diets will also depend on how evenly that growth is shared within counties. Figure 5.2 provides poverty projections from the World Bank for low- and middle-income countries.[106] It shows that, globally, a 3% goal for poverty at US$1.90 a day can be achieved by 2030 only if the poorest 40% of the population in each country grow faster than the rest. This kind of inclusive growth will probably help to improve diet quality faster given that those at lower incomes have diets that are low in calories and micronutrients.

[103]The possible policy interventions that may affect these drivers (and therefore future diets) are beyond the scope of this report.
[104]Reardon and Timmer (2014) [105]Ruel and Alderman (2013) [106]Lakner, Negre and Prydz (2014)

FIGURE 5.2: Global poverty projections with different assumptions about the inclusivity of growth



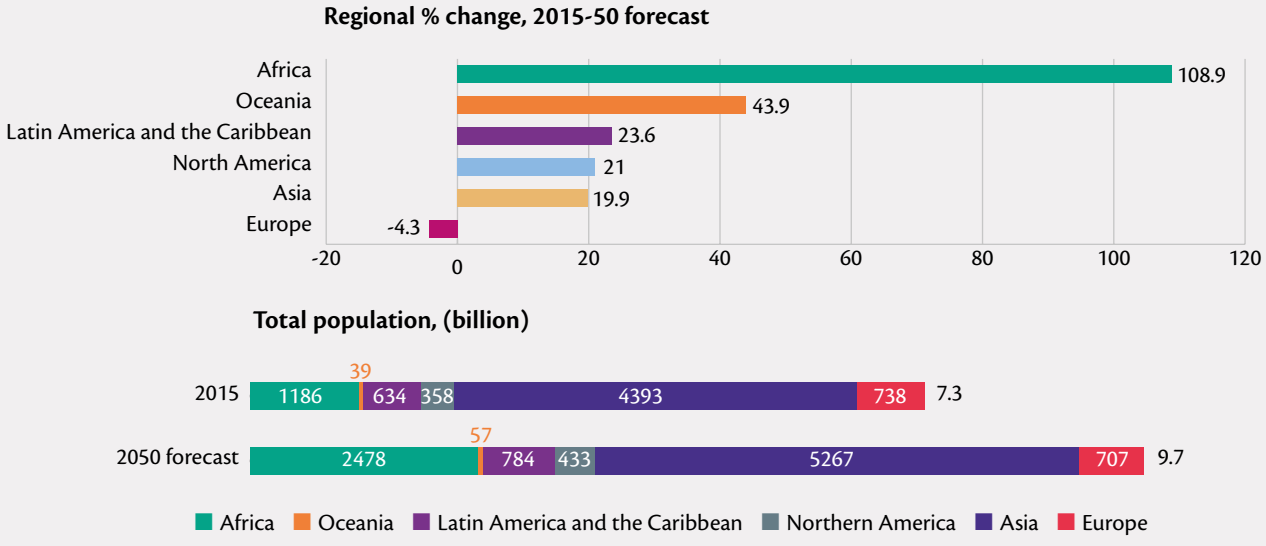
Source: Lakner, Negre and Prydz (2014) Note: pp: Percentage points

5.2 Population change

Along with income, changes in the size and structure of populations will be a strong predictor of future diets. Figure 5.3 presents the latest population projections from the UN.

Africa's population is estimated to double in the next 35 years. Asia's population will also increase substantially in absolute terms, reflecting its current magnitude more than future rates of growth.

FIGURE 5.3: Projected changes in population, 2015–50



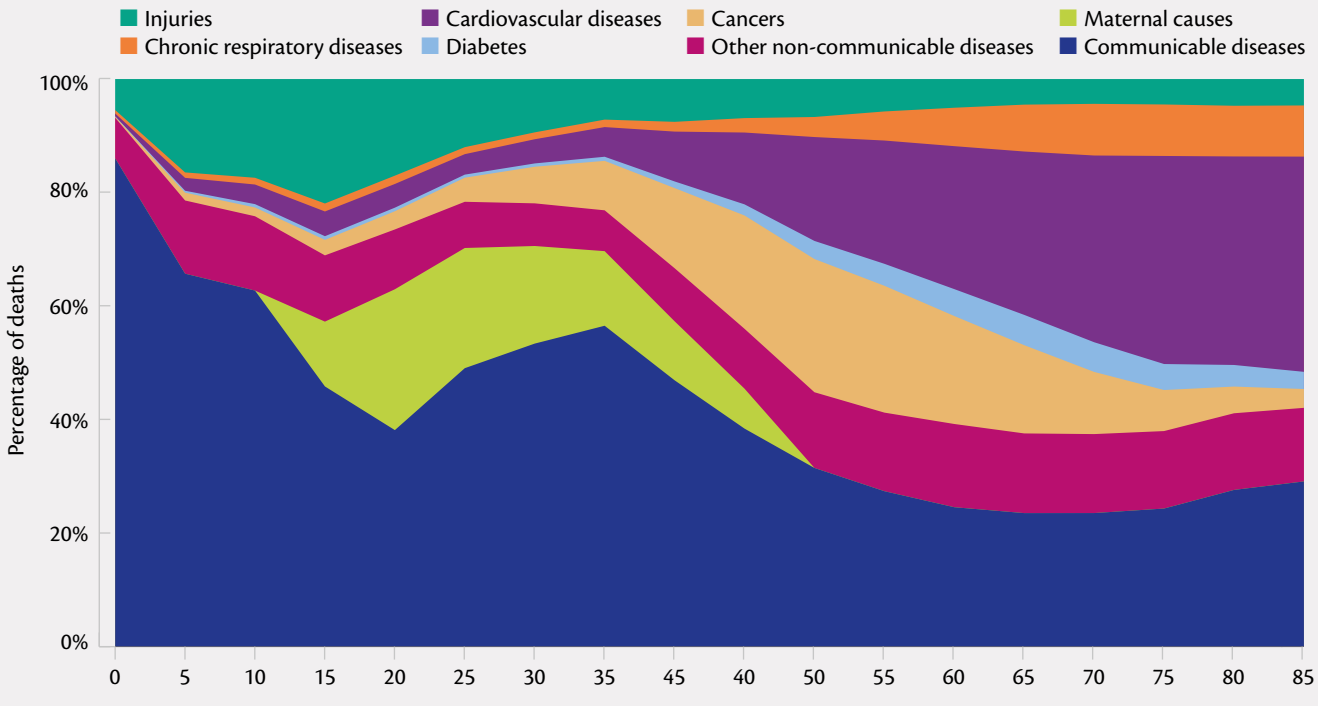
Source: The Economist (2015), based on data from the UN Department of Economic And Social Affairs, Population Division (2015)

Overall, population growth rates are decelerating as declining birth rates catch up with declining mortality rates. The demographic transition is slowest in sub-Saharan Africa[107] and parts of South Asia.[108] The declines in birth rates, due to declines in fertility rates, are positive for maternal and child nutrition status.[109] Maternal nutrient stores will be depleted by frequent births, and household time, asset and food resources can be focused on fewer household members. The increased potential for vulnerable groups to access higher-quality diets under these circumstances is clear.

The demographic transition means that many populations are ageing and this has implications for diets. An individual's nutrient needs change with age; certain nutrients become harder to absorb via diets (e.g. vitamin B12), in part because older adults often eat less, but also because their diets change. The diet quality of adults becomes more important as populations age, as mortality becomes related to non-communicable rather than communicable diseases. Figure 5.4 shows the recent mortality profiles for women in low-income countries. After 40 years of age, NCDs such as cancers and cardiovascular disease become the leading cause of death.

The demographic transition also results in the potential for a demographic "dividend", where the ratio of those of working age to those of non-working age reaches a peak. Many policy makers in South Asia and sub-Saharan Africa regard this as a dividend because there is an assumption that the new, young labour market entrants will be able to gain jobs that generate wage rates that keep households out of poverty. This is another reason to focus on the diets of infants and young children – to support their cognitive development and achievements in school – achievements that should be rewarded in the labour market in subsequent decades.[110]

FIGURE 5.4: Profile of female deaths by age, low-income countries



Source: WHO (2014), Figure 3.4

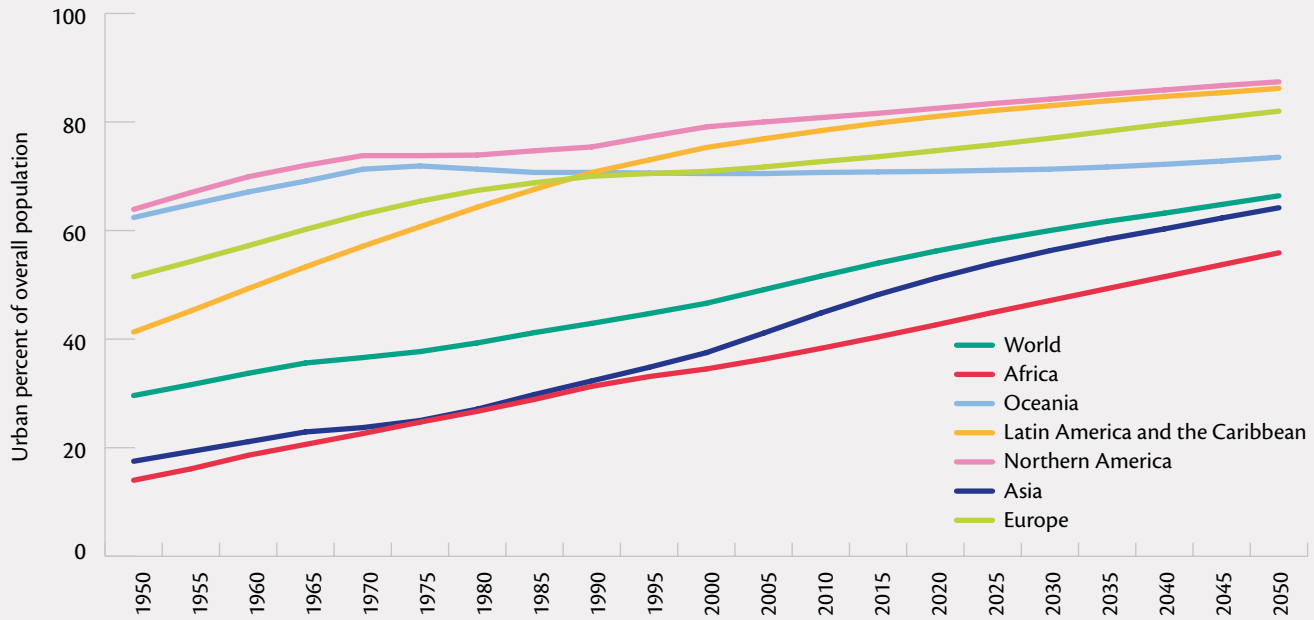
The diet quality of adults becomes more important as populations age, as mortality becomes related to non-communicable rather than communicable diseases.

[107]Canning, Raja and Yazbeck (2015) [108]Mehrotra (2015) [109]Bhutta et al. (2013); Headey et al. (2015) [110]Norris et al. (2014)

5.3 Urbanization

The percentage of the world's population that lives in urban areas is increasing steadily and most rapidly in sub-Saharan Africa and Asia (Figure 5.5). This is due to rapid population growth in towns and cities and rural to urban migration.[111] Urbanization generates opportunities and challenges for food systems.[112] Much of the focus of work on urbanization and food systems has been in two areas: the links between expansion of built up areas and the loss of agricultural land, and on the relationship between urban incomes and diets.[113]

FIGURE 5.5: Urban percentage of overall population by region, 1950–2050



Source: Reardon (2016), based on UN DESA (2014)

Being an urban dweller is associated with a number of consumer preferences and lifestyle changes including:

- year-round access to fresh foods
- greater access to commercially fortified foods[114]
- access to a greater share of food in the market
- more people working outside the home and an associated demand for foods that are more highly processed and require less preparation time
- greater exposure to food marketing and advertising that influences norms and preferences on what is healthy and what is not
- more sedentary lifestyles and fewer safe built-up areas to encourage physical exercise
- the lack of home space to prepare food and hence a greater reliance on affordable street food which is often high in fat and salt.[115]

Along with income, changes in the size and structure of populations will be a strong predictor of future diets.

Urbanization generates opportunities and challenges for food systems.

[111]Matuschke (2009) [112]Reardon (2016) [113]Seto and Ramankutty (2016) [114]Miller (2016) [115]Steyn et al. (2014)

TABLE 5.1: Challenges and opportunities faced by consumers arising from urbanization

Factors affecting consumers	Opportunity for high-quality diets	Challenge to high-quality diets
Increased access to fresh foods	Fresh foods such as fruits and vegetables are good for high-quality diets	Consumption of ASF above certain levels are not consistent with high-quality diets
Greater access to commercially fortified foods	Promotes access to micronutrients for vulnerable groups who can afford fortified foods	Improper fortification or high cost of fortified foods are a risk for high-quality diets
Accessing a greater share of food from markets	A greater range of processed foods such as legumes, vegetables and fruits are available	A greater range of high-energy-dense, low-micronutrient foods are available. Consumers are more vulnerable to food price changes due to international and domestic shocks
Demand for foods that require less preparation time	Availability of good quality prepared food saves time for other activities that are important for nutrition, such as child care	Foods may be unaffordable or low in nutrient quality or unsafe
Demand for foods outside home	Availability of good quality prepared food saves time for other activities that are important for nutrition, such as child care	Foods may be unaffordable or low in nutrient quality or unsafe

Source: Compiled by the authors

Eating outside the home is found to be a risk factor for higher fat intake and low-micronutrient levels in high-, middle- and low-income country settings.[116] Food safety (Chapter 2) is also an issue of growing concern in urban areas.[117] And food loss and waste are more of a risk if food chains get longer as they tend to do in urban areas.[118] These challenges and opportunities are summarized in Table 5.1.

For producers, the spatial concentration of urban populations provides markets for domestic food producers, provided there is sufficient land and water available to meet this increased demand and internal transport and market infrastructure costs are not prohibitive. But where land or water resources are converted from farm to residential or industrial use, or where infrastructure quality is poor and costs are high, domestic production will struggle to respond to the increased demand. Imported food may be cheaper and preferred if its quality is higher and its processing makes it more convenient to the consumer.

Whatever the source of food, rapid urbanization provides opportunities but also major challenges to food systems and the infrastructure underpinning them. For example, in Nigeria, one of the countries that is urbanizing most rapidly, estimates suggest that a Nigerian city of four million inhabitants would require one three-tonne truck of food supplies entering the city every 90 seconds to feed the population.[119] This represents a major challenge for policy makers who are aiming to strengthen their agricultural sector. It also poses a serious threat to the livelihoods of domestic farmers. Land use, water use and investments in infrastructure for transport, storage and other logistics need to be made in line with maximizing livelihood opportunities for domestic farmers and diet quality opportunities for all. Conurbations provide opportunities to sell processed and fresh products in areas of high population density, opportunities that large supermarkets as well as smaller retail outlets are well placed to take up. Choices made about location, size and fees and taxes will be critical to the ability of these businesses to improve the access of vulnerable people to food that is nutritious, safe and affordable.

The fact that so many research studies find rates of urban dwelling to correlate to lower levels of undernutrition and higher levels of overweight and obesity – even controlling for income levels[120] – highlights both the challenges and the opportunities of urbanization when it comes to the production and acquisition of high-quality diets. Policy makers need to find ways of strengthening the positive links between urbanization and diet quality, while not blunting its ability to help reduce hunger and undernutrition. City and municipal governments will have a particularly important role to play here, given that they tend to have a large influence over the evolution, design and planning of urban infrastructure and local business regulations.

[116]Lachat et al. (2012) [117]FAO (2010) [118]Reardon (2016) [119]Bayo (2006) [120]IFPRI (2016a)

5.4 Policies and processes of globalization

Policies implemented to drive forward economic globalization have wrought changes throughout the food system, in turn with significant implications for diet quality. Policies, notably the process of trade liberalization, have influenced national food production, transport, processing and imports and exports and investments between countries.[121] This in turn has influenced food availability, prices, promotion and safety in different ways.

Some have argued that these policies have reduced hunger.[122] The impacts on undernutrition are hard to trace but it seems evident that there is potential for both coherence and incoherence between trade policy and undernutrition outcomes.[123] In food safety, trade liberalization likewise has had both positive and negative implications.[124] For forms of malnutrition associated with excess and imbalance, evidence indicates that trade liberalization and foreign direct investment, facilitated by advances in information and communication technology, have made it easier to make certain food and drink products (e.g. oils, ultra-processed foods and sugar-sweetened beverages) more available to consumers in low- and middle-income countries.[125] For example, a cross-country analysis[126] estimated that low- and middle-income countries that enter free trade agreements with the US have a 63% higher level of sugar-sweetened beverage consumption per capita than countries that did not, controlling for GDP per capita and urbanization levels. This has led some to argue that globalization has been a driver of the obesity epidemic.[127] Extensive econometric analyses of several data sets show that globalization is substantially and significantly associated with an increase in the individual propensity to be overweight among women.[128] Results from a quantitative analysis using a fixed-effects panel model indicate that the impact of trade openness and foreign direct investment is positive and significant in low- and middle-income countries.[129]

Trends in recent decades in globalization, as measured by the KOF Index of Globalization[130] suggest that, while globalization appears to be levelling off globally, it is still increasing steadily in South Asia and sub-Saharan Africa, where current rates of market penetration by large-scale food businesses and retailers are relatively low. Given the growing demand for highly processed and ultra-processed foods in the lower- and upper-middle-income countries (Chapter 3) and the relative lack of food-based dietary guidelines from these country groupings (Chapter 2), they are likely to be targets for food processing and retailing companies seeking to grow their markets.

5.5 Climate change

There are important consequences of climate change for diet in terms of adequacy and quality. Direct consequences include rising temperatures, more volatile rainfall and the increased incidence of extreme weather events that will adversely affect crop and livestock productivity. The impacts of these changes will depend on the overall increase in greenhouse gases in the atmosphere and associated rise in average global temperatures.

Twenty years of global studies show crop yields to be negatively affected by climate change in the tropical areas where hunger is most widespread.[131] In general, they indicate that crop yields will increase in Northern Europe under a range of climate change scenarios. At a global level, Nelson et al.[132] present results for nine economic models with common exogenous drivers for seven climate change scenarios across four crops (staples) and 13 regions. They find most models predicted a significant increase in food prices that will reduce the affordability of foods.

From a diet quality perspective, it would be helpful to know which foods are most vulnerable to climate change. A recent study published in the Lancet[133] sheds some light on this issue. Using a coupled agriculture-health model, it is estimated that climate change over the period to 2050 will generate 529,000 net additional deaths from diet-related causes compared to a reference scenario of no climate change. Most of these deaths would occur in the low- and middle-income countries of the Western Pacific and South-East Asia and would be due to changes in the lower availability of fruits and vegetables which would lead to 534,000 climate-related deaths. These would far outweigh the health benefits associated with reductions in red meat availability due to climate change (29,000 avoided deaths). In addition, other studies[134] estimate that the global impacts of elevated carbon dioxide on the zinc content of grains, tubers and legumes will place 138 million people at new risk of zinc deficiency (and hence at risk of diarrhoeal diseases) by 2050. Those likely to be most affected would be living in Africa and South Asia, with nearly 48 million in India.

Ocean acidification is a further consequence of climate change, leading to a fall in the availability of oceanic calcium carbonate

[121]Hawkes, Grace and Thow (2015); FAO (2004) [122]Anderson (2010) [123]Hawkes (2015); FAO (2015b) [124]Hawkes (2015) [125]Thow and Hawkes (2009); Baker, Kay and Walls (2014); Hawkes et al. (2009) [126]Stuckler et al. (2012) [127]Malik, Willett and Hu (2013) [128]Goryakin et al. (2015) [129]Miljkovic et al. (2015) [130]The KOF Index of Globalization measures the three main dimensions of globalization: Economic, social and political. For more information see: http://globalization.kof.ethz.ch/
[131]Wheeler and Von Braun (2013) [132]Nelson et al. (2014) [133]Springmann et al (2016b) [134]Myers et al. (2015)

used by marine species to build their shells. Seafood is a good source of nutrients and omega-3 fatty acids which are beneficial to health (Chapter 2). The consequences of acidification include a reduction in the availability of shellfish, losses of coral reefs (which offer habitats to many fish species) and possible collapse of the krill fisheries in the Southern Ocean. Such adverse impacts on the oceans would aggravate the impact on marine ecosystems from overexploitation of many fish stocks and cut availability of high-value nutrient-rich seafood.[135]

Indirect effects on diet quality will be influenced by the agreements made at the 21st Conference of the Parties (COP) to the UN Framework Convention on Climate Change (UNFCCC) held in Paris in December 2015.[136] At this conference, all governments agreed to keep average global warming to well below 2ºC and to aim towards 1.5ºC. This implies a significant cut in greenhouse gas emissions below current trends, to avoid breaching the global carbon budget. If such policy shifts do indeed occur, they are likely to have a range of indirect consequences for diets. For example, a rise in energy costs will have implications for the costs of fertilizer production, food transport, trade, storage, processing and transformation, although the net impacts on diet quality will be context specific and are currently under-researched.[137]

5.6 Depletion of natural resources

The quantity and quality of food available depends on fundamental natural assets – soils, water and biodiversity – and how they are managed. The evolution of diets and food systems will be constrained by natural resource availability and the intensity of natural resource use of different diets (see Chapter 3).

As population and incomes grow, the world's natural resource base is under increased pressure. For example, the last 50 years have seen significant degradation of soils in many parts of the world[138] with the conversion of natural habitats into cropland and the intensive cultivation of inappropriate areas. The expansion of cropped areas has led to the erosion of biodiversity, with potentially serious consequences for human health and well-being.[139] Biodiversity is important as it constitutes a reservoir of genetic diversity from which future crops, medicines and livestock can be developed. The web of insects, soil micro-fauna and other life forms, provides critical services for ensuring the production of crops and livestock. For example, estimates have been made of the global impacts of a loss in pollination services by important insect species on the production of fruits, vegetables and nuts and seeds and how this translates into changes in micronutrient intake. Keeping calorie intake constant, they show that the reduction in the availability of these foods of high dietary value, arising from a 50% loss in pollination services, would be associated with an additional 700,000 deaths per year and 13.2 million DALYs per year due to increases in NCDs and micronutrient malnutrition.[140]

Agriculture relies heavily on freshwater from rainfall, groundwater and irrigation systems. In many areas, however, groundwater extraction has led to a large fall in the water table. The principal grain producing regions of northwest India, northeast Pakistan, northeast China and the Midwest of the US have all experienced high rates of groundwater depletion.[141] Currently, agriculture consumes more than 70% of freshwater but with rising demand from industrial, energy and domestic uses, irrigation systems will need to adopt more water-efficient methods of use if food yields are to be maintained. Climate change is expected to aggravate water shortages, increasing rainfall volatility and erosive run-off.

In assessing the environmental implications of different dietary elements, as Chapter 2 shows, the manner in which particular foods are produced and processed matters. For example, the carbon and water footprint of red meat from intensive, stall-reared cattle is very different to meat from extensive cattle herds, fed on natural pastures, whose dung is a valuable source of plant nutrients for local farmers.[142]

Increased pressure on natural resources will constrain food production and may stimulate technical progress, while driving diets in unpredictable and highly context-specific ways. The growing consensus on the need to price scarce resources, such as water, should provide strong incentives both to increase the efficiency of resource use and to generate technical improvements.

[135]McCauley et al. (2015) [136]United Nations (2016a) [137]Wheeler and Von Braun (2013)
[138]FAO and ITPS (2015) [139]Godfray and Garnett (2014) [140]Smith et al. (2015) [141]Whitmee et al. (2015) [142]Garnett (2014)

5.7 Implications

This chapter has briefly considered the main drivers that will directly influence diet quality in the future. Drivers offer both opportunities and threats for the attainment of high-quality diets.

- Income growth will allow households to access more food and a more diverse basket of foods that contribute to a high-quality diet but it will also enable the purchase of a greater quantity and variety of food products that undermine diet quality.
- Urbanization offers greater convenience to consumers in terms of low-cost food prepared outside the home, but also creates risks around food safety.
- Globalization offers investment opportunities for food businesses to generate incomes, activity and employment but also makes foods high in sugar, salt and fats more available.
- Climate change policy should reduce the consumption of foods with a high carbon footprint.

There are thus genuine trade-offs and tensions to be resolved. Moreover, all the aforementioned drivers are interrelated. For example, higher incomes, urbanization and globalization are closely interconnected.

Yet there is one place – albeit an extensive one – where these drivers converge to influence diet: the food system.[143]

- Income and population growth increases the demand for food which places stresses on the food system; the food environments produced by food supply systems are influencing what food is available to be purchased with new income and how much food is purchased per capita.
- Urbanization has a myriad of effects on food systems that influence diet quality, including taking land away from food production while also providing hubs of innovation for new ways of producing food and by being the locus of mass retail and 'out of home' food provisioning.
- The processes of globalization have had a transformative impact on food systems by enabling the development of new supply chain networks and changing food environments.
- Climate change and natural resource depletion place stresses on food production and increase the volatility of supply; the production of elements of a high-quality diet (e.g. meat for those with low levels of consumption) contributes to climate change through increased CO_2 emissions.

The food system becomes a place where tensions emerge, but where they can also be resolved. In the next chapter, we consider in more detail how food systems work and the elements within them that could be levered to reorient the trajectory of diets into the future.

Policy makers need to think through systematically the possible combination of contextual drivers that shape their own food systems. But how should they then use this information? The following chapters will highlight where policy makers should look within their food systems to leverage them towards high-quality diets (Chapter 6) and what they can do to achieve that (Chapter 7).

Finally, we offer a typology (Table 5.2) for policy makers to help with the identification of the diet issues that their specific contextual drivers are likely to push them towards. Table 5.2 presents 16 typologies of contextual drivers that can be applied at the national or subnational level. Guided by the analysis in this chapter we identify four contextual stratifiers, each with two values: low-middle-income; rural/urban; low-high-market liberalization; and natural resource-rich/-poor.

Middle-income contexts tend to be less vulnerable to calorie shortfalls (i.e. food takes up a smaller share of overall income) and ASF consumption (i.e. high-income elasticities), but remain vulnerable to low fruit and vegetable intake (because income elasticities for these products tend to be lower) and to excess levels of red meat, excess calorie intake and salt, sugar and unhealthy fat intakes (due to increased purchasing power). Higher levels of market liberalization reduce the transactions costs of marketing both fresh and processed foods. Urban contexts are more vulnerable to food and lifestyle choices that prioritize the intake of prepared food and food away from home, foods that can be energy-dense and micronutrient-sparse and can be prepared in unsafe ways. Environments that are natural resource-poor[144] can be vulnerable to climatic variation (e.g. due to fragile water tables or lack of forest cover), have low levels of biodiversity, high population density and overuse of scarce natural resource capital (e.g. due to crop choices that require high levels of energy or water).

Drawing on a range of evidence, Table 5.2 links these 16 typologies to 10 key features of high-quality diets as identified in Chapter 2. The features cover calorie adequacy, the availability of key foods that are markers for diet quality, food safety, climate resilience and natural resource use. The relevant stratifiers for typologies and the diet quality priorities will vary by context: Table 5.2 presents an example for others to adapt and shows that different typologies lead to different sets of priorities for food systems. The nature of the diet challenges generated by 4 of the 16 typologies with suggestions for countries that contain these contexts is provided in Box 5.1.

[143]Seto and Ramankutty (2016) [144]See Solability Sustainable Intelligence (2016) for an index of the natural capital of different countries. High-ranking countries are characterized by the availability of abundant water combined with a tropical climate, rich biodiversity and availability of other natural resources.

Box 5.1: Underlying driver typologies and the dietary challenges they generate

Many low-income countries contain regions that reflect the following typologies: **Typology 1** – a context with low-income, rural, low-market liberalization and natural resource-poor people. Bangladesh is an example of a country that contains this typology. **Bangladesh** is low-income, two-thirds rural, has a low level of natural capital and has relatively low levels of globalization according to the KOF Index.[145] Clearly, hunger remains an issue in Bangladesh, diet quality is low and food systems need to be made more resilient. These are the challenges for the food system to address. But the context is complicated by the fact that one third of the population is urban and in these areas, market liberalization will be higher and dietary challenges will include the lowering of consumption of some diet components. For example, Bangladesh has the 99th highest estimated prevalence of diabetes (out of 193 countries). Countries increasingly have to address multiple contexts within their borders.

Typology 8 contexts are low-income, urban, high-market liberalization and natural resource-rich. They need to focus more on improving diet diversity and food safety – while not forgetting about hunger in critical rural areas. **Zambia** is an example of a country that contains such a context. It is low-income (at least in terms of poverty rates), is more urban than most sub-Saharan African countries, is natural resource-rich and has relatively high levels of globalization. It will still need to tackle hunger, while increasing the diversity of food group consumption, address food safety issues in rapidly growing urban areas and manage the availability and consumption of ultra-processed foods, which tend to be energy-dense and low in fibre and micronutrients.

Typology 13 contexts are medium-income, urban, high-market liberalization but natural resource-poor. They should focus primarily on increasing the consumption of fruits and vegetables, reducing the incentives to consume ultra-processed foods and pay extra attention to food safety and reducing ecological footprints. **Egypt** is an example of a country containing this typology. It is a lower-medium-income country; it has a relatively high percentage of its population in urban areas, and is natural resource-poor with moderate to high liberalization of markets. Calorie availability is very

Source: Compiled by the authors

TABLE 5.2: Contextual driver types and priorities for food system goals

Contextual Driver Types	Example of Food System Goal		
	Address calorie shortfalls	Incentivize higher ASF intake	Incentivize higher F&V intake
1. Low income, rural, low market liberalization, natural resource poor	Higher	Higher	Higher
2. Low income, rural, high market liberalization, natural resource poor	Higher	Higher	Higher
3. Low income, rural, low market liberalization, natural resource rich	Higher	Higher	Higher
4. Low income, rural, high market liberalization, natural resource rich	Higher	Higher	Higher
5. Low income, urban, low market liberalization, natural resource poor	Medium	Medium	Higher
6. Low income, urban, high market liberalization, natural resource poor	Medium	Medium	Higher
7. Low income, urban, low market liberalization, natural resource rich	Medium	Medium	Higher
8. Low income, urban, high market liberalization, natural resource rich	Medium	Medium	Higher
9. Medium income, rural, low market liberalization, natural resource poor	Medium	Medium	Higher
10. Medium income, rural, high market liberalization, natural resource poor	Lower	Lower	Medium
11. Medium income, rural, low market liberalization, natural resource rich	Medium	Medium	Higher
12. Medium income, rural, high market liberalization, natural resource rich	Lower	Lower	Medium
13. Medium income, urban, low market liberalization, natural resource poor	Lower	Lower	Medium
14. Medium income, urban, high market liberalization, natural resource poor	Lower	Lower	Medium
15. Medium income, urban, low market liberalization, natural resource rich	Lower	Lower	Medium
16. Medium income, urban, high market liberalization, natural resource rich	Lower	Lower	Medium

Source: Compiled by the authors

[145]ETH (2016) [146]IFPRI (2016a) Note: F&V refers to fruits and vegetable

high and is concentrated on staples. Fruit and vegetable consumption needs to increase and overall calories need to decrease. Food systems need to be resilient and to reduce their ecological footprint given the reliance on irrigated food production.

Typology 16 contexts are medium-income, urban, high-market liberalization and natural resource-rich. They should focus on reducing ultra-processed food intake and lowering red meat intakes, excess calorie intakes, salt, added sugar and unhealthy fats intakes. Extra attention should also be paid to food safety. **Indonesia** is an example of a country that contains this context. It is medium-income, majority urban, relatively natural resource-rich and has relatively high levels of globalization. It is suffering from high levels of multiple forms of malnutrition:[146] stunting of children aged under five, anaemia in women and adult overweight and obesity. It has many diet quality challenges and in fact will contain many of the 16 driver typologies listed here within its borders.

Drivers offer both opportunities and threats for the attainment of high-quality diets.

We present this typology not as a definitive answer to the question of what should different food systems be focusing on. Each context will generate its own drivers, types and priorities. But we do encourage policy makers and their teams to take the time to create a version of Table 5.2 that suits their national and subnational contexts. It is one way of identifying different typologies within their own country and making explicit the breadth of food system outcomes they want to see. The construction and completion of such a typology can also serve as a way of identifying and reconciling competing priorities and trade-offs in an inclusive, consensus-building process.

As we will show in the following two chapters on food systems and food environments – and the policies that can shape them – the need for inclusive and evidence-informed policy processes is vital for making policy decisions that lead to the attainment of food system goals.

Incentivize reduced ultra-processed foods intake	Incentivize lower red meat intake	Reduce excess calorie intake	Incentivize lower salt, added sugar, unhealthy fat intake	Pay extra attention to food safety	Increase climate resilience of food systems	Reduce ecological footprints of food systems
Lower	Lower	Lower	Lower	Lower	Higher	Higher
Medium	Lower	Lower	Lower	Medium	Higher	Higher
Lower	Lower	Lower	Lower	Lower	Medium	Medium
Medium	Lower	Lower	Lower	Medium	Medium	Medium
Medium	Lower	Lower	Lower	Medium	Higher	Higher
Higher	Lower	Lower	Medium	Higher	Higher	Higher
Medium	Lower	Lower	Lower	Medium	Medium	Medium
Higher	Lower	Lower	Medium	Higher	Medium	Medium
Medium	Lower	Lower	Lower	Lower	Higher	Higher
Higher	Medium	Medium	Medium	Medium	Higher	Higher
Medium	Lower	Lower	Lower	Lower	Medium	Medium
Higher	Medium	Medium	Medium	Higher	Medium	Medium
Medium	Medium	Medium	Medium	Medium	Higher	Higher
Higher	Higher	Higher	Higher	Higher	Higher	Higher
Medium	Medium	Medium	Medium	Medium	Medium	Medium
Higher	Higher	Higher	Higher	Higher	Medium	Medium

6 Food systems and diet quality

KEY MESSAGES

- Food systems comprise all the processes involved in keeping us fed: The food supply, food environments and food consumers all form part of the broader food system.
- The food supply system comprises interrelated subsystems which take food from farm to fork, including agricultural production; storage, transport and trade; transformation retail and provisioning.
- There has been a shift in the balance of food systems over past decades – from "local systems" with short food chains and minimally processed foods delivered in local markets or consumed by the producing household towards more "global systems". These have long food chains involving multiple pathways and/or transformations where consumers rely on the market to access food.
- Agricultural production has vital implications for diet quality because it forms the basis of the foods that people eat. Evidence shows the food availability from agriculture has increased and foods other than staples have increased faster. But there is still a bias in terms of investment and policy in the public and private sectors towards a small number of staple crops.
- Foods produced by agriculture do not necessarily reach consumers in the form in which they are harvested. They may be used as animal feed, lost during storage, contaminated with food safety risks or transformed into processed foods. The nature of these changes has important implications for diet quality.
- Beyond agriculture, the food supply system influences which foods move through the system and in what form, which are made available and affordable to different people, and how safe they are.

6 Food systems and diet quality

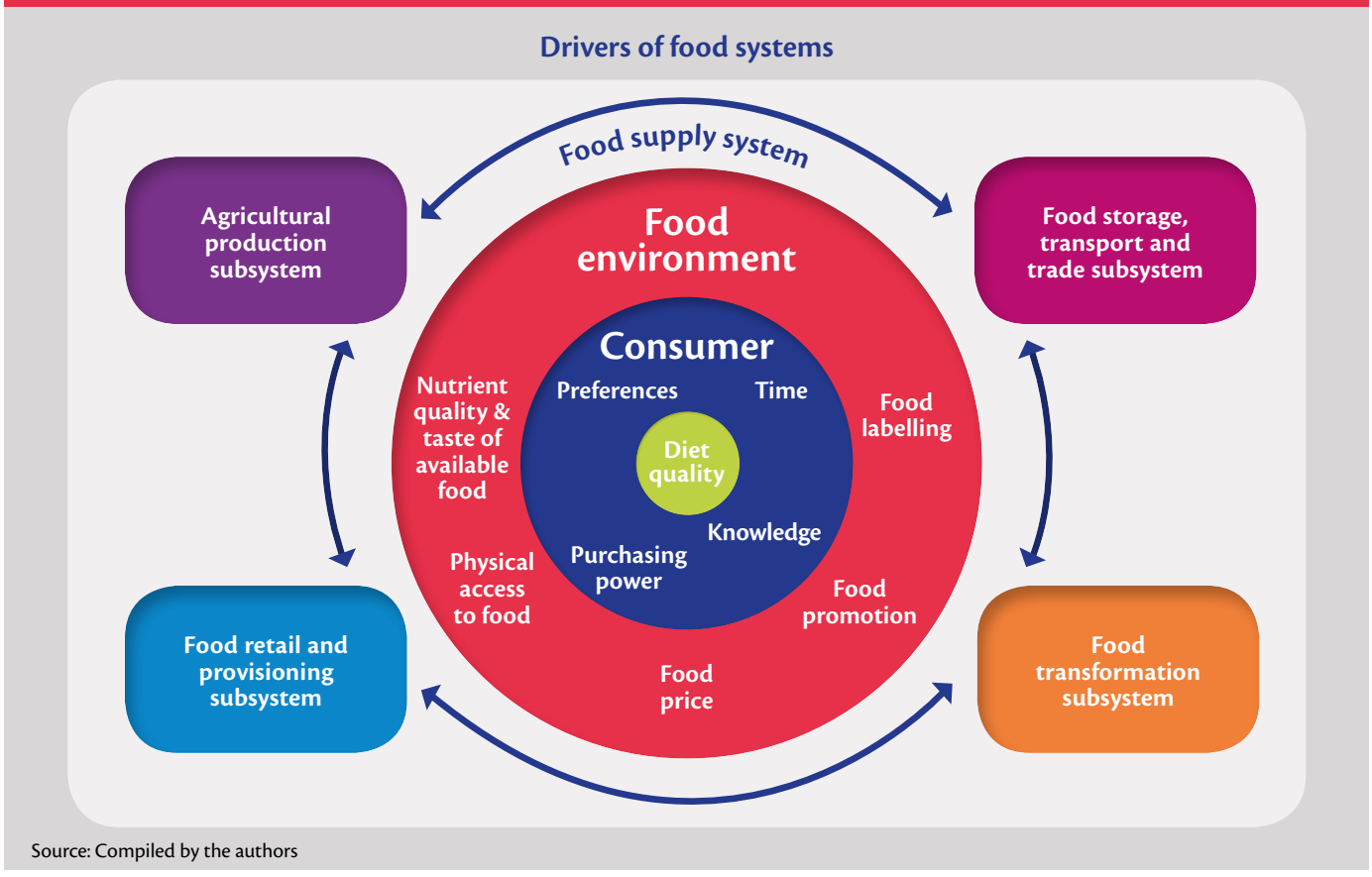
In Chapter 1, we outlined what we mean by 'the food system'. This chapter provides an in-depth view of the elements of food systems and their implications for diet quality.

6.1 What are food systems?

Food systems comprise all the processes involved in keeping us fed: growing, harvesting, packing, processing, transforming, transporting, marketing, consuming and disposing of food. They include the inputs needed and outputs generated at each step. A food system operates within and is influenced by social, political, economic and natural environments.[147] This and other definitions of food systems[148] emphasize that food systems produce food, that they are made up of a broad set of components from production to consumption and that they are influenced by external social, political and other drivers. Food systems also produce outputs, which are not food as by-products or co-products – such as ethanol (for fuel).

Consumers are an important part of food systems. They eat the food produced by the system and, in so doing, influence what the system produces. Food cultures – values, beliefs and social norms around food – play an important role in shaping what people eat and what they demand from the food system. Food choices and dietary patterns represent a central aspect of human societies and have strong symbolic value in the development of personal and social identities. Consumer incomes and other socio-economic characteristics also play a key role in what people can afford to buy. Food skills and literacy also influence food production, purchasing and consumption.

FIGURE 6.1: Conceptual framework for the links between diet quality and food systems



Source: Compiled by the authors

[147]Eames-Sheavly et al. (2011) [148]Neff, Merrigan and Wallinga (2015); Babu and Blom (2014); Ericksen (2008); Reardon and Timmer (2012); Sobal, Khan and Bisogni (1998); Combs et al. (1996); HLPE (2014); Dixon (2015)

However, in a two-way street, food systems in turn play a role in shaping consumer food preferences, attitudes and beliefs and therefore food cultures more broadly.[149] They influence what consumer's decide to acquire and eat and, therefore, their diet quality. This is because they shape what can be termed 'food environments' – the foods available to people in their surroundings as they go about their everyday lives and the nutritional quality, safety, price, convenience and promotion of these foods. Food environments play an important role in shaping diets because they provide the choices from which people make decisions about what to eat; they constrain and signal what people can acquire and, as a consequence, influence the decisions people make.[150] Food environments circumscribe how income can be spent on food.[151]

Underpinning these food environments are food supply systems. Often referred to as the 'food supply chain' or 'food value chain'" they are in fact a series of interlinked and interacting subsystems that create food environments. Four of the core subsystems can be categorized as follows (Figure 6.1).

1) **Agricultural production subsystem,** which represents the primary production of foods and related inputs, including the production of arable crops, horticulture, animals and fish. It is vitally important as it provides the basis of what foods are available to the rest of the food system and generates income for farmers and the rest of the economy through multiplier effects.

2) **Food storage, transport and trade subsystem,** in which food is handled, treated, stored, packed, moved, transported and traded. This subsystem starts immediately after food is harvested, which is often on the farm. It also involves all aspects of moving and transporting food products from production to consumption and provides the physical links between the other food subsystems.

3) **Food transformation subsystem,** in which produced foods are transformed into final products, which can occur at the postharvest stage and/or later. Although many crops such as roots, fruits and vegetables can go almost straight from field to retail, much of the food produced enters the food transformation subsystem and is first processed in some way. How food is processed has a strong influence on the form in which foods are available for consumers. This subsystem also includes the marketing of these products.

4) **Food retail and provisioning subsystem,** comprises the actors who move products through the market into the hands of the consumer. Markets, informal retail, street vendors, supermarkets and small stores are where the majority of the world's population acquires their food.

6.2 Changes in food systems

Food systems across the globe are highly diverse. They comprise 'local systems' made up of 'short food chains' with minimally processed foods delivered in local markets or consumed by the producing household, 'global systems' with 'long food chains involving multiple pathways and/or transformations' and 'everything in between.[152]

While food systems remain diverse, there has been a significant shift in the balance over past decades towards 'long chain' models. This means that more food is transported, traded and transformed after it leaves the farm, leading to a shift in emphasis away from the farm into later food supply systems – sometimes referred to as the 'middle of the chain.' These food supply chains are increasingly complex, specialized, and have strong vertical links between production stages.[153] The main shifts have been:

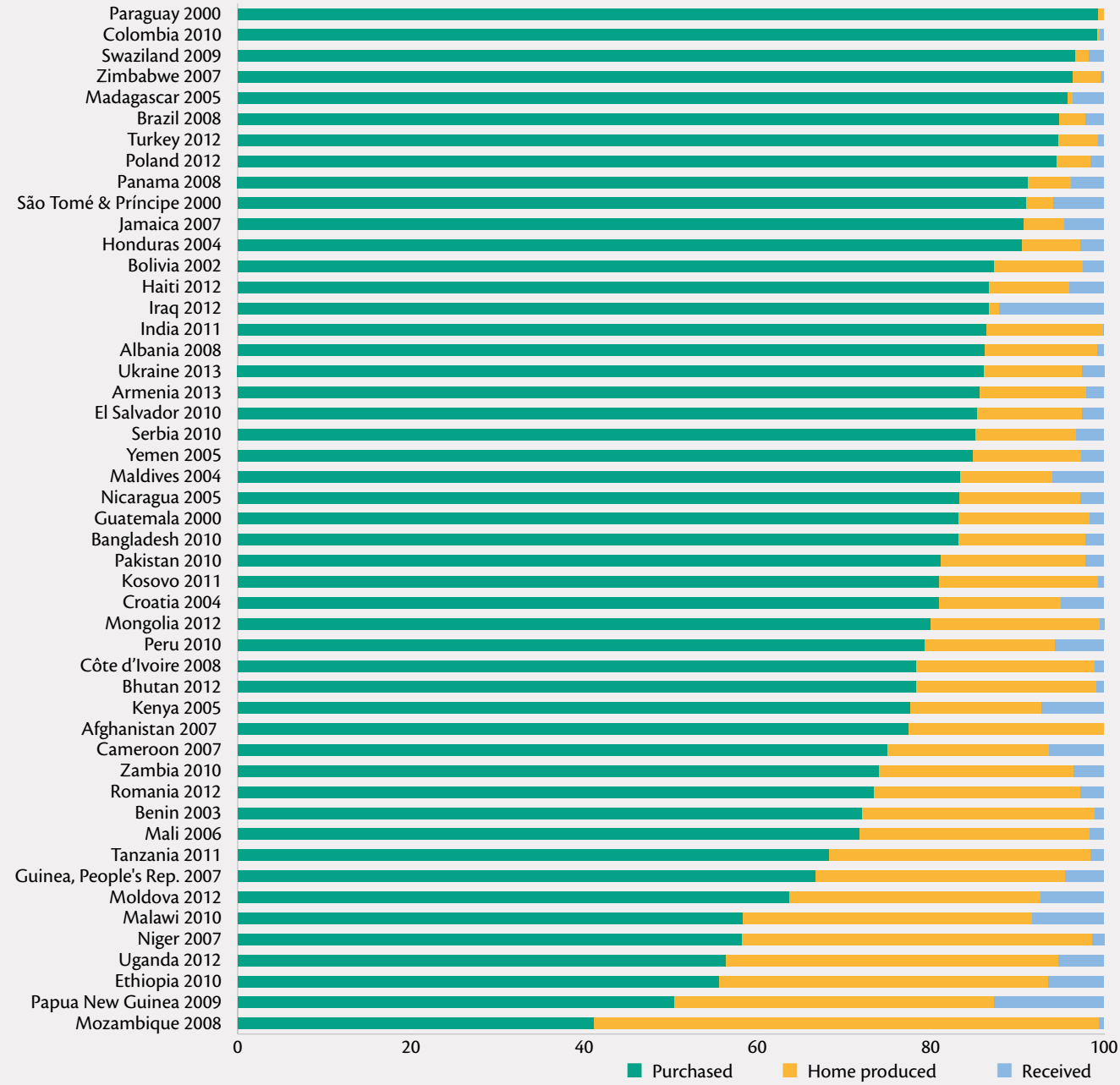
- **Distancing between production and consumption,** from shorter to longer chain food systems, in which consumers are physically further from the point of production.
- **From producing foods direct for the cooking pot to producing ingredients for food processing.** Raw ingredients from agriculture are increasingly transformed through the food system. Soya oil can become a trans fat; chicken can be combined with vegetable oils and refined carbohydrates to make ultra-processed food; and fruits can be used as an ingredient in processed foods high in sugar. Many ingredients from agriculture are also transformed into an increasingly diverse array of non-food products such as biofuels.
- **From growing food to eat, to buying it.** The most recent available data show that in most low-middle-income countries, the majority of food is not grown by the households that consume it, but acquired from the market through the food retail and provisioning subsystem (Figure 6.2).[154]
- **An increase in role and power of the private sector relative to the public sector.** As food chains have lengthened and food transformation increased, enormous opportunities have

[149]Hawkes et al. (2015) [150]Swinburn, Egger and Raza (1999); Glanz et al. (2005); Story et al. (2008); Swinburn et al. (2011); Vandevijvere and Swinburn (2015); Hawkes et al. (2015); Herforth and Ahmed (2015) [151]Herforth and Ahmed (2015) [152]FAO (2013); Brunori et al. (2016) [153]FAO (2013) [154]Note, the World Bank LSMS unit informs us that comparable time series data for the value of food are not available.

grown for private sector investment in the food system. Today, the private sector – ranging from farmers to huge transnational corporations – is the main actor in the food system. The power and concentration of large agribusinesses, manufacturers and retailers, has grown. This in turn means that power structures in food systems have changed, which not only influences what is produced, but political decision making.[155]

- **A shift of value, labour and power to the middle of the food chain.** Though still far less than high-income countries (e.g. 85% in the United States),[156] in low-middle-income countries, these middle segments have grown to form 30–40% of the value added and costs in food value chains.[157] Human labour in agriculture remains extensive, although the development of mechanical, chemical and biological technologies has enabled substitutions for labour in the field. There has been a concomitant shift away from labour in the home to the middle of the chain, reflecting shifts towards the use of technology in food preparation, as well as additional food processing and preparation in the food system.

FIGURE 6.2: Percentage of household value of food consumed by source of acquisition



Source: Data compiled by the World Bank, LSMS team.

[155]IPES-Food (2015) [156]Canning (2013) [157]Reardon (2015)

6.3 Elements of food supply systems relevant to diet quality

In each of the parts of the food supply system illustrated in Figure 6.1, there is a wide range of different elements relevant to diet quality. In each case, their influence is exerted through their impact on 'food environments'. Here we exemplify a small number of these elements and why they matter for diet quality. The elements exemplified are summarized in Table 6.1 and discussed further in Chapter 7 as food system entry points for policy.

TABLE 6.1: Examples of food supply systems elements that have the potential to influence diet quality via food environments

Subsystem and element	Why it matters for diet quality
Agricultural production	
1) Degree of diversity of production	Can have direct impact on availability of diverse foods for farmer households and local diets where people are served by short-chain food systems reliant on local production; provides the global pool from which all foods are made
2) Amount (quantity) of production of different foods and ingredients	Drives the quantity of different foods available for human consumption globally
3) Productivity of different foods and ingredients	Key influence over the amount of production of different foods and ingredients
4) Agricultural research investments	Influences productivity of different crops and the nature of the crop production systems
Storage, transport and trade	
5) Degree of food losses and waste	Influences the degree to which different foods produced by agriculture can reach consumers
6) Contamination with food safety risks	Influences whether food is safe
7) Transport infrastructure	Influences availability and prices of different foods
8) Imports and exports	Influences availability and prices of different foods, including by providing ingredients for food processing
Transformation	
9) Investment in food processing	Influences the type of food processing, which in turn affects whether ingredients produced by agriculture are transformed into food, which contribute to high diet quality or undermines it
10) Degree and type of food advertising and promotion	Influences the appeal of different foods to consumers
Retail and provisioning	
11) Degree of traditional vs. modern retail	Influences convenience in physical access to different types of foods, prices and food safety

Source: Compiled by the authors

6.3.1 Agricultural production

Agricultural production produces the foods and ingredients that form the basis of the quantity and diversity of foods available for human consumption. What is produced has vital significance for diet quality. There are a large number of elements of agricultural production subsystems that have implications for diet quality. We focus on just four: (1) diversity of production; (2) amount of different foods grown, raised and caught; (3) degree of productivity; and (4) agricultural research. Cutting across these four elements is the question of how foods are produced, which also has significant implications for not just what is produced, but how safe it is and a broad range of other food system outcomes. We recognize the central importance of this question but do not deal with it here.

The first key element in the agricultural production subsystem we exemplify as potentially important for diet quality is the diversity of production i.e. what crops are being grown and raised other than staples such as starchy roots. In local short chains, the diversity of local production can affect local diets. In the shortest of chains – i.e. when producers consume their own production – there is evidence that increasing on-farm diversity can have a strong impact on dietary diversity among subsistence-oriented producer households.[158] At the landscape level, where

[158]Kumar, Harris and Rawat (2015); Jones, Shrinivas and Bezner-Kerr (2014); Dillon, McGee and Oseni (2015); Hoddinott, Headey and Dereje (2015); Sibhatu, Krishna and Quam (2015)

There is evidence that increasing on-farm diversity can have a strong impact on dietary diversity among subsistence-oriented producer households.

linkages to more distant markets are weak, production diversity can also be associated with dietary diversity.[159] But food is often sold on to markets far away from the location of production and where producers do participate in markets, the role of on-farm production diversity is less significant in contributing to improved diet quality. The diversity that is available to non-farm households is a function of a combination of local, national and global markets, not what is just produced locally. This in turn reflects what is produced nationally and globally.

When measured at a global level, the degree of diversity of production of broad food groups has changed very little over past decades.[160] Nevertheless, FAOSTAT data indicate that there have been changes in the amount of different foods that are produced (Figure 6.3). This is the second element we identify as important for diet quality. Figure 6.3 shows that between 1961 and 2011, total calorie availability increased globally and in all regions. The proportion that has come from non-staple foods has also increased, except in the US and more recently in Europe, where this has remained constant at a relatively high value (Figure 6.3).[161] The amount of staples (cereals and starchy roots) has not increased per capita since the mid-1980s (i.e. increased in total, but not per person), while the quantity of most of other foods has (Figure 6.4). Steady increases have been seen in the availability of vegetable oils, various ASF and fruits and vegetables. However, some regions show very little change in food availability patterns over this 50-year period.

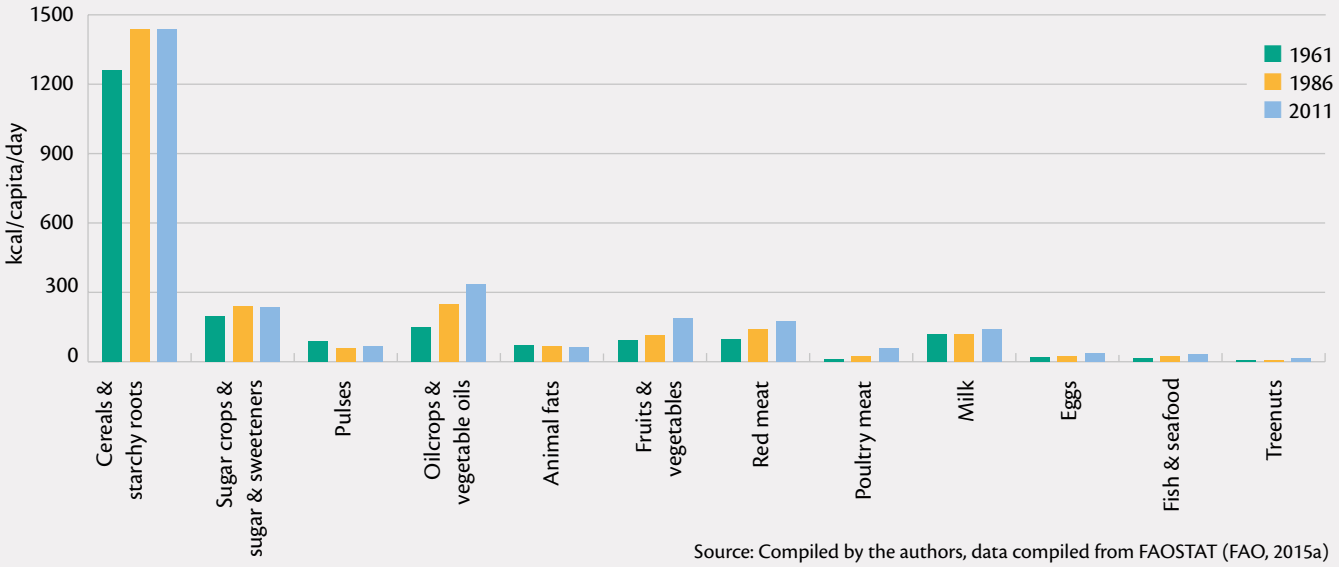
The degree of diversity of production of broad food groups has changed very little over past decades.

FIGURE 6.3: Percentage of energy from non-staple foods and total dietary energy per capita by region, 1961–2011

Source: Masters (2016)

[159]Duriaux and Baudron (2015) [160]Remans et al. (2014); Khoury and Jarvis (2014) [161]FAO food balance sheets provide a picture of national food availability for human consumption by taking total production of different commodities and adjusting these for imports, exports and food losses during storage and transportation, from which average per capita food availability can then be estimated.

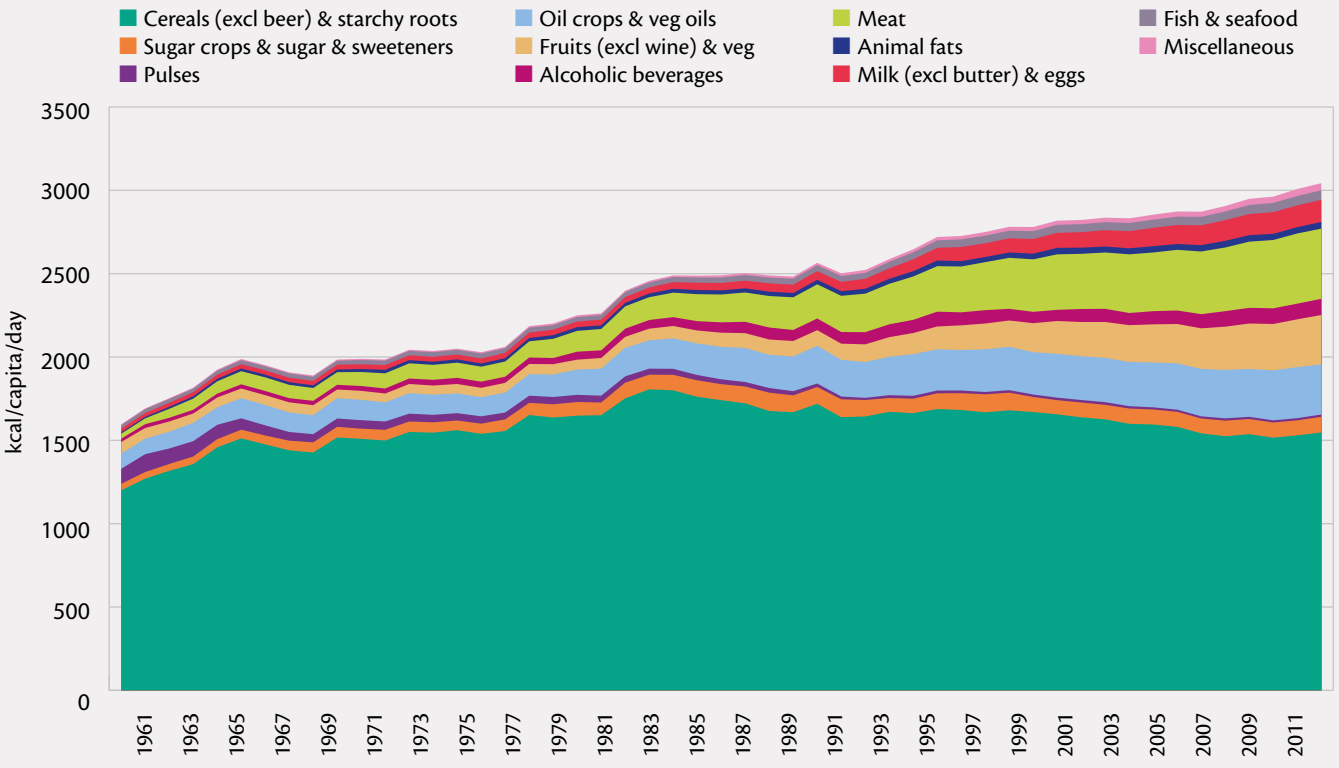
FIGURE 6.4: Global per capita availability per day (kcal) from different foods: 1961, 1986 and 2011



Source: Compiled by the authors, data compiled from FAOSTAT (FAO, 2015a)

Behind these global changes are large regional variations. East Asia (dominated by China, Japan and South Korea) has shown the biggest transformation. In the 1961–2011 period, per capita calorie availability increased from 1600 to just over 3000 and the percentage of calories from sources other than cereals and starchy roots has doubled, from 25% to 50%. This shift from a calorie profile dominated by cereals towards a much more diverse set of calories sources is illustrated by Figure 6.5.

FIGURE 6.5: East Asia, 1961–2011, calories from different categories



Source: Compiled by the authors, data compiled from FAOSTAT (FAO, 2015a)

South-East Asia is the next most transformed region, with per capita calorie availability increasing from 1800 to 2700 and the percentage of calories from sources other than cereals and starchy roots increasing from 25% to 40% over the 1961–2011 period. South Asia and Africa have shown mainly increased calorie intakes over this period (Africa: from 2000 calories to 2700 and the percentage from non-cereals and starchy roots increased from only 34% to 37%, while for South Asia, the corresponding figures are 2300 to 2500 calories and 34% to 40%).

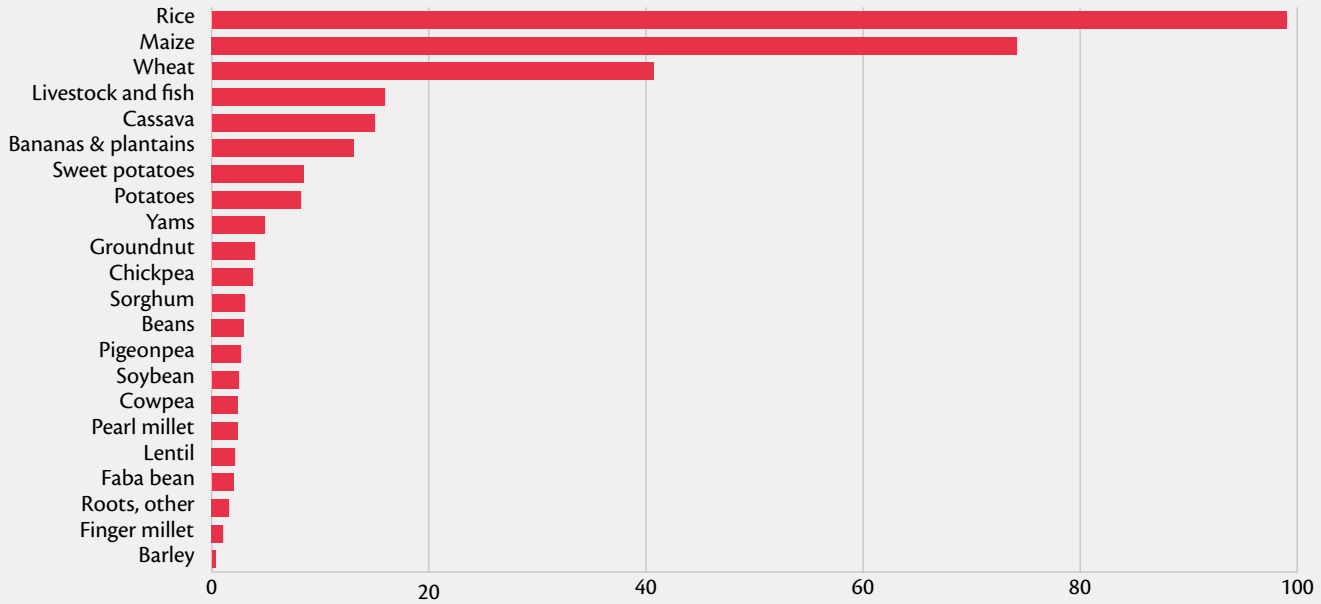
A core driver of the quantity of foods produced is productivity. Between 1960 and 2000, productivity growth in low- and middle-income countries saw cereal and crop yields rise substantially,[162] while that of legumes declined.[163] This has been reflected in increases in cereals and declines in legume availability, although the latter has started to increase and cereals have stabilized (Figure 6.4). Since the mid-1980s, the rate of increase in productivity has slowed but productivity per unit of input (e.g. breeds, feeds) as well as unit of land – i.e. total factor productivity (TFP) – has risen.[164] In 2001–10, increases in TFP accounted for more than three-quarters of the total growth in agricultural output worldwide.[165]

In meat, increasing productivity has played a fundamental role in the rising supply. Increases in edible output per unit of livestock have arisen from developments in feeding, breeding and housing. The shift to poultry meat is because poultry is more readily scalable than ruminants and delivers greater efficiencies of production. They tend to have shorter breeding cycles than ruminants and so selection for particular traits, such as yield, delivers results more quickly. Intensive poultry production systems also use less land.[166]

Productivity is not the only source of growth. For example, increases in palm oil production is largely a result of increasing land allocation. It has been calculated that area expansion has accounted for well over 90% of palm production growth in Indonesia and 77% in Malaysia.[167]

Increases in productivity reflect another element of the agricultural production subsystem we identify as potentially important: agricultural research.[168] For many years, investment into agricultural research has focused on a small number of cereals.[169] The Consortium of International Agricultural Research Centers (CGIAR), which commands the most significant capacity to conduct agricultural R&D in low- and medium-income countries, still allocates about half of its resources to rice and maize (Figure 6.6). In the private sector, about 45% of research investment is directed towards just one crop: maize.[170] This share is considerably higher than maize seed's 25% share of the overall seed market, but reflects the industry's experience that maize seed is the most profitable seed to produce. Other crops have received relatively little funding. Notably, global funding for pulse crop productivity is estimated to be far less than invested in maize[171] and comes mostly from the public sector.[172]

FIGURE 6.6: CGIAR research funding allocated to specific crops in 2012 (in US$ million)



Source: Compiled by the authors, based on data in Khoury and Jarvis (2014)

[162]For example 208% for wheat, 109% for rice, 157% for maize, 78% for potatoes and 36% for cassava [163]Evenson and Gollin (2003); Pingali (2012) [164]TFP is the ratio of total output to total inputs in a production process. It increases if more food is produced per unit of aggregated inputs or total inputs [165]Fuglie and Rada (2013) [166]Garnett (2016) [167]Villoria et al. (2013) [168]Thirtle, Lin and Piesse (2003); Pardey, Alston and Piggott (2006) [169]Bereuter and Glickman (2015) [170]Fuglie et al. (2011); Cavalieri (2011) [171]Murrell (2016) [172]Particularly CGIAR, USAID and the Bill & Melinda Gates Foundation.

6.3.2 Storage, transport and trade subsystem

After foods and ingredients are produced, they are stored and packed and/or subject to treatment of some type (e.g. drying, washing, cooling, ripening) and then transported and traded. Elements of this subsystem that are potentially important for diet quality include the degree of postharvest losses and waste, contamination with food safety risks, transport infrastructure and imports and exports.

Table 6.2 illustrates how food is lost across the food system, starting with production all the way to consumption.[173] In middle- and high-income countries, much food is wasted at the later parts of the food system. However, in low-income countries, postharvest losses are particularly significant and even in high-income countries, the majority of food waste occurs before the household gets it (Figure 6.7). This has implications for diet quality because it influences the quantity of different type of foods produced by agriculture that pass through the system. Crops that have high losses during the postharvest period are important for basic dietary adequacy in low-income countries e.g. rice, cassava, groundnuts, as well as perishable foods vital for high diet quality e.g. fruits and vegetables and milk.[174] The crops which have the highest levels of losses are fruits and vegetables due to the warm and humid climate of many low- and middle-income countries as well the seasonality that leads to unsaleable gluts; losses mean that over half of fruits and vegetables produced in low-income countries are never consumed, compared to 20% for cereals.[175] Legumes are generally more difficult to store than cereals and are more subject to losses from pests.

Food safety risks also occur throughout the food supply subsystem (Table 6.3). As with food loss and waste, food safety risks begin with production, particularly for livestock systems where animal parasites, pathogens and toxins affecting consumer health enter the system.[176] Postharvest is particularly critical in influencing whether these hazards are eliminated or spread and can also be where new hazards are introduced. For example, aflatoxins are toxins produced by fungi that attack cereals and groundnuts in the field and represent a serious food safety hazard for low-income populations who consume relatively large quantities of staples (such as maize and groundnuts) in tropical regions.[177] While aflatoxins do appear in the production stage, poor postharvest practices (mostly related to poor drying) and storage conditions can increase aflatoxin prevalence. If the storage environment is humid and warm, crop infection and cross-contamination can occur as if the grain is not well dried prior to storage, it can be an ideal environment for fungal growth.[178]

TABLE 6.2: Food loss and waste along the value chain

Production	Handling and storage	Processing and packaging	Distribution and market	Consumption
Definition				
During or immediately after harvesting on the farm	After produce leaves the farm for handling, storage, and transport	During industrial or domestic processing and/or packaging	During distribution to markets, including losses at wholesale and retail markets	Losses in the home or business of the consumer, including restaurants/caterers
Includes				
Fruits bruised during picking or threshing	Edible food eaten by pests	Milk spilled during pasteurization and processing (e.g., cheese)	Edible produce sorted out due to quality of vegetables	Edible products sorted out due to quality
Crops sorted out at post harvest for not meeting quality standards	Edible produce degraded by fungus or disease	Edible fruit or grains sorted out as not suitable for processing	Edible products expired before being purchased	Food purchased but not eaten
Crops left behind in fields due to poor mechanical harvesting or sharp drops in prices	Livestock death during transport to slaughter or not accepted for slaughter	Livestock trimming during slaughtering and industrial processing	Edible products spilled or damaged in market	Food cooked but not eaten
Fish discarded during fishing operations	Fish that are spilled or degraded after landing	Fish spilled or damaged during smoking		

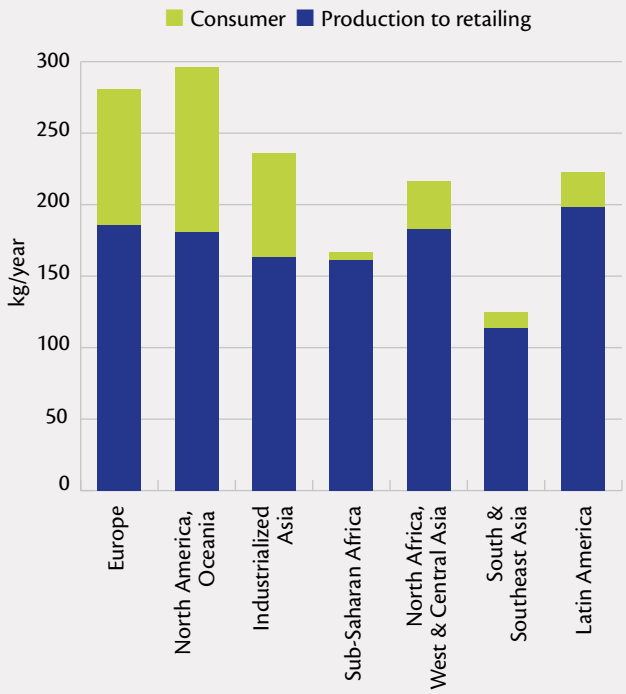
Source: Lipinski et al. (2013)

[173]Lipinski et al. (2013) [174]FAO (2011) [175]FAO (2011) [176]Grace (2015) [177]Unnevehr and Grace (2015) [178]Unnevehr and Grace (2015); Global Panel (2016b)

Transport infrastructure is an element of the food system that matters for diet quality because of its role in perishable food systems. Underdeveloped and unreliable national electric and transport grids in low- and middle-income countries can make cold storage of perishables both difficult and expensive, so reducing the incentive to make them available and adding significant costs. For example, in the Indonesian archipelago in the mid-2000s, the inadequacy of the local transport grid meant that procurement of fruits from rural areas was more expensive than procurement from Thailand.[179] Similarly, Mexico imports 20% of its fresh fruit and vegetable produce due to cheaper cross-border procurement systems.[180] This can also be the case for staples. For example, evidence indicates it is easier to import broken Thai rice to consumers in Dakar than to transport local production from irrigated rice production in the Senegal River Valley.[181]

This indicates the importance of the amount, type and destination of food imports and exports. According to FAO, the value of global food exports has grown almost three-fold between 2000 and 2012 and by around 60% in terms of volume in the same period and this trend is predicted to continue.[182] While cereals have historically been the most traded food, other commodities have become more important. Trade in fish and seafood has increased and is now among the most traded of all food commodities from a value perspective, exceeding the combined trade value of sugar, maize, coffee, rice and cocoa.[183] International trade in fruits and vegetables has expanded at a higher rate than trade in other agricultural commodities, particularly since the 1980s. Not only has world trade in fruits and vegetables gained prominence but also the variety of commodities has expanded. In the vegetable oil market, trade has facilitated the greater availability of soya and palm oil and in the meat market, of dark chicken meat.[184]

FIGURE 6.7: Per capita food losses and waste at consumption and pre-consumption stages (kg/year) in different regions



Source: FAO (2011), Figure 2

Trade has also affected the inputs and ingredients used in food production. Imports of animal feed have been shown to be a direct stimulus to greater meat production while sugar and a variety of products are imported to produce ultra-processed foods.[185] This means many processed foods that are produced locally use ingredients sourced globally.

TABLE 6.3: Examples of food safety risks in the food supply subsystem

Food supply subsystem	Examples of food safety risks
Agricultural production	If the fields are sprayed with contaminated water for irrigation, fruits and vegetables can be contaminated before harvest. Livestock may be infected by parasites and pathogens that can affect human nutrition and health.
Food storage, transport and trade	If refrigerated food is left on a loading dock in warm weather, it could reach temperatures that allow bacteria to grow. Peanut butter can become contaminated if roasted peanuts are stored in unclean conditions or come into contact with contaminated raw peanuts.
Food transformation	During the slaughter process, pathogens on an animal's hide that came from the intestines can get into the final meat product.
Food retail and provisioning	If a food worker continues to work while he or she is sick and does not wash his or her hands carefully after using the toilet, he or she can spread pathogens by touching food.

Source: Compiled by the authors, based on Center for Disease Control and Prevention (CDC, 2015)

[179]Natawidjaja, Reardon and Shetty (2007) [180]Reardon (2004)
[181]Del Pozo-Vergnes and Vorley (2015) [182]FAO (2015b) [183]Asche et al. (2015) [184]Hawkes (2010) [185]Hawkes (2010)

The diet quality implications of imports are both positive and negative.[186] First, importing food can make it easier and cheaper to access a more diverse food supply, thus potentially boosting diet quality. Yet benefits may not accrue to low-income countries where diets are least diverse. One recent cross-country study indicated that food imports are associated with a more diverse food supply in high- and middle-income countries, but not in low-income countries.[187] Second, while many foods associated with high diet quality have been increasingly traded, fruit and vegetable trade tends to focus on exporting from low- and middle-income countries to high-income countries, where supply is less of a problem.[188] Third, while imports can boost adequacy of supply, they have also facilitated the manufacturing and availability of ultra-processed foods in low- and middle-income countries.[189]

More trade has both negative and positive implications for food safety.[190] On the negative side, increased food trade may introduce new safety hazards, revive previously controlled risks and spread contaminated food widely. Although most food imported into low-income countries can be reliably considered of higher sanitary quality than food in the domestic markets, low-income countries may also be more vulnerable to illegal imports of unsafe food. On the positive side, there have been important evolutions in public regulation of food safety of imported products, especially perishable animal and plant products, which are most associated with foodborne disease. For example, the SPS Agreement is reported to have increased the use of scientific risk assessment in the formulation of food safety measures.

6.3.3 Food transformation subsystem

Many of the ingredients produced by agriculture are processed in some way in the food transformation subsystem, meaning they reach consumers in a different form to when they were grown, raised or caught.[191] For example, maize is processed into high fructose corn syrup and many arable crops become animal feed. As discussed in Chapter 1, there is a diversity of processing with mixed implications for diet quality. Some forms of processing can help increase food availability, extend seasonality through the hunger gap and make food safer to eat. Food fortification can also add nutritional value. Yet processing can also lower the nutritional quality of products, such as producing trans fats from soya oil, chicken nuggets from plain chicken and ultra-processed foods from a range of different ingredients so they become high in energy-dense, free sugars and unhealthy fats and salt, and low in dietary fibre.

Elements that are potentially significant for diet quality in the food transformation subsystem include the allocation of investments into different types of food processing and advertising and other forms of promotion.

All processed foods require investment in technology and facilities required to produce them. For example, the production of one of the world's most consumed ultra-processed foods, instant noodles, involves 13 different steps from entering to leaving the factory.[192] If the focus of processing in one of the world's largest food companies (listed in Appendix 5, Table 6.1) is an indicator, a large proportion of investment in processing dollars goes into grain-based foods, snacks and confectionery. In addition to the four companies with highly diversified portfolios that include them, six companies focus on grain-based and baked products, three on snacks, sweets/candy and/or soft drinks. Four focus on meat, including processed meats and four focus on dairy, including products with added sugars. These companies are growing fastest in low- and middle-income countries, where they are often market leaders and have clear strategies to drive further growth.[193]

The power and concentration of these companies have grown over time. For example, in Latin America, the market shares of the four largest firms in the carbonated soft drinks and sweet and savoury snacks markets are over 60%.[194] This in turn reflects foreign direct investment by high-income countries' food manufacturing companies into low- and middle-income countries. Figure 6.8 shows the scale of Coca-Cola's foreign and direct investment since 2010. These processes enable companies to produce sugary, fatty and salty foods at lower cost and make them more available in low- and middle-income countries. It also stimulates competition with local 'b-brands' thus further stimulating the market[195] and/or encouraging foreign expansion of firms from lower-middle-income countries into low-income countries.[196] For example, JBS, a Brazilian meat company, has purchased numerous companies in the United States, Australia and Europe and is now rated as the world's third largest food company (Appendix 5).

One of the outcomes of larger food processing companies is greater ability and incentive to develop highly differentiated products in a cost-efficient manner.[197] The number of new and rebranded products produced by these companies has steadily increased over time. For example, in 2012, the Coca-Cola Company had more than 3500 products in their global portfolio. Owing to consumer concern about the nutritional quality of ultra-processed foods and drinks, this includes growth of varieties with reduced calorie content; 800 of their 3500 products were low- and no-calorie beverages in 2012 and in 2011 alone, the company launched more than 100 low- and no-calorie beverages.[198] However, full calorie versions remain their core brand.

A second key element of the food transformation subsystem for diet quality is the advertising and other forms of promotion of these products. This is a fundamental part of the food

[186]UNSCN (2015) [187]Remans et al. (2014) [188]Huang (2010) [189]Baker, Kay and Walls (2014) [190]Hawkes et al. (2015)
[191]Hawkes et al. (2012) [192]WINA (2016) [193]e.g. Mondelēz International (2016a); Mondelēz International (2016b)
[194]PAHO (2015) [195]Wei and Cacho (2001) [196]Dawar and Frost (1999) [197]Hatanaka, Bain and Busch (2006) [198]Cited in Hawkes (2014)

transformation subsystem because the ability to promote products is a powerful incentive to produce them in the first place. This is particularly important in low- and middle-income countries so that products previously unfamiliar to consumers can be promoted. Promotion is the process by which information about newly innovated products is communicated. Food and beverage companies spend large amounts on advertising, accounting (including alcohol retail) for 17% of global media spending in 2012.[199] Coca Cola and Nestlé, which were among the top 10 largest global advertisers in 2014, together spent US$6.21 billion[200] – equivalent in size to almost two-thirds of the entire UK overseas aid budget. A recent review[201] of food marketing practices concludes that food promotion in high-income countries has been geared towards increased access to cheaper, bigger and tastier calorie-dense food. Much consumer influencing is conducted "below the radar" using less obvious methods than advertising, such as brand association, sensory complexity, the size and shape of portions, packages and serving containers. These practices are also following similar patterns in low- and middle-income countries.[202] There is convincing evidence that advertising influences food choice among children.[203]

6.3.4 Food retail and provisioning subsystem

The point where most consumers meet the food supply system is the food retail and provisioning subsystem – the markets that sell the food that has been produced, transported, traded and transformed in earlier subsystems. Food retailing and provisioning (e.g. supply of food through schools and restaurants) is critical for diet quality because it influences all aspects of food environments i.e. what food is available to people, its nutritional quality, safety, price, convenience and promotion.

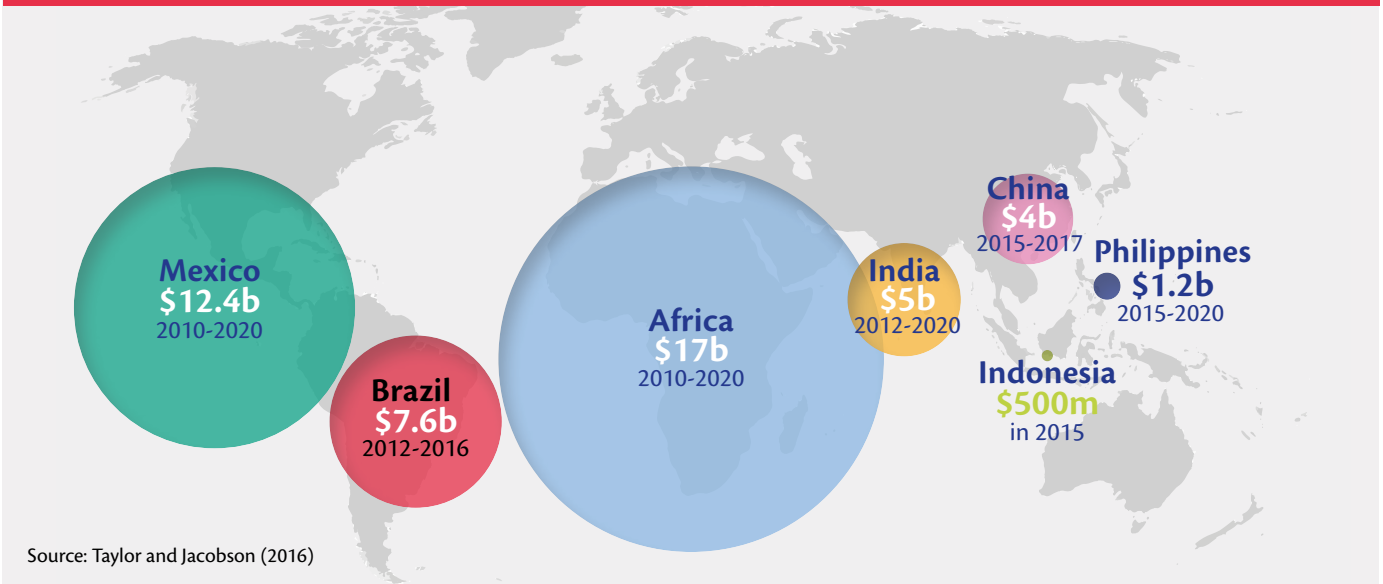
Like all food supply subsystems, there is a tremendous diversity in retail and other forms of provisioning. One distinction is between "traditional" and "modern" retail.

The degree of distribution between different forms of food retail and provisioning influences diet quality. A number of communities, particularly in rural or poor urban areas, are still heavily dependent on local "wet markets" for fruits and vegetables, livestock products and staples.[204] However, in a growing number of low- and middle-income countries, the modern retail sector is shaping physical access to food.[205] Modern food retail channels include convenience stores and supermarkets (including hypermarkets and discount stores) and these are gradually replacing traditional retail outlets, including outdoor wet markets, food/drink/tobacco specialists, independent small grocers and other grocery retailers.

This trend has different implications for different kinds of food. Nearly 60% of processed food is distributed through supermarkets, which are spreading rapidly in the upper-middle-income countries. Figure 6.9 shows how modern retail is beginning to dominate processed food distribution in upper-middle-income countries, while lower-middle-income countries, in common with low-income countries, continue to rely on traditional retail outlets for processed foods and soft drinks.[206]

The effect of modern retail on the accessibility of fresh foods has been rather different. Figure 6.10 shows that the share of fresh foods in supermarkets in different country income types has been relatively constant over the past 15 years, which suggests that supermarket growth has not had much impact on retail patterns for these commodities. One factor thought to be holding

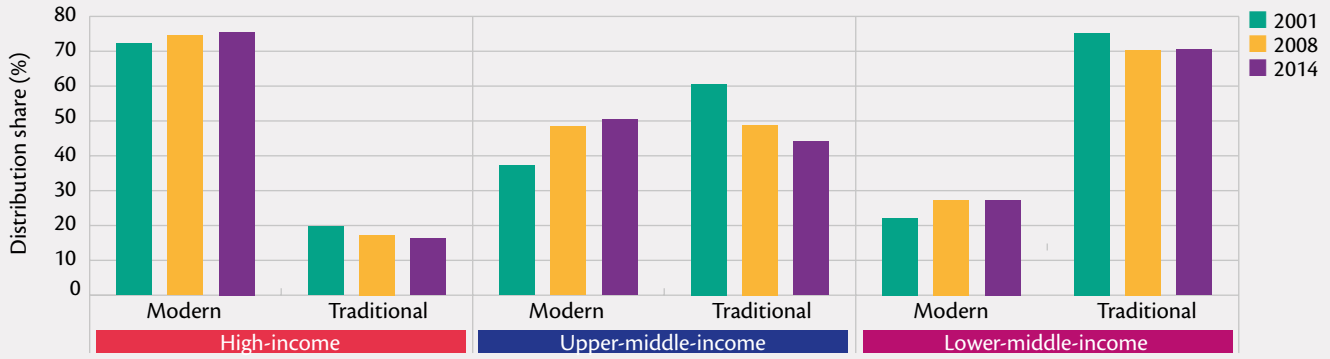
FIGURE 6.8: Coca-Cola's International Investments



Source: Taylor and Jacobson (2016)

[199]AdvertisingAge (2013) [200]Statista (2016) [201]Chandon and Wansink (2012) [202]Hawkes (2002); Taylor and Jacobson (2016) [202]Hastings et al. (2003); Hastings et al. (2006); McGinnis, Gootman and Kraak (2006); Cairns, Angus and Hastings (2009) [204]Gómez and Ricketts (2013) [205]Reardon et al. (2003) [206]PAHO (2015)

FIGURE 6.9: Total processed food distribution by modern vs. traditional channels in country income groups, 2001–14 calculated as a percentage of total retail value



Source: Baker (2016) based on data from Euromonitor
Note: Modern grocery retail channels include convenience stores and supermarkets (including hypermarkets and discounters); traditional channels include food/drink/tobacco specialists, independent small grocers and other grocery retailers.

FIGURE 6.10: Fresh food distribution by modern vs. traditional retail channels by country income groups, 2006–14, calculated as a percentage of total volume

Source: Baker (2016) based on data from Euromonitor
Note: Country income-categories included only the following – high-income countries were Australia, Germany, Japan, Russian, UK and US; upper-middle-income countries, Brazil, China, Mexico and South Africa; and the lower-middle-income countries, India and Morocco.

back greater positive benefits from supermarket growth on fresh food consumption are the logistic and cold chain challenges of penetrating the fresh food sector.[207] It may also be that traditional outdoor markets remain highly cost competitive for fresh fruits and vegetables and can be easier to access by low-income groups.[208]

Another form of food provisioning is the food outlet that serves ready-to-eat food, such as street vendors and fast food restaurants/chains. The consumption of food outside the home is growing rapidly in low- and middle-income countries, especially in urban areas. For example in Brazil,[209] the national 2008–09 survey found that 18% of calories were purchased outside the home (and for adult men in the top income quartile this rose to 28%). This has been shown to be a risk factor for higher fat intake and low micronutrients in high-, middle- and low-income country settings.[210] One source of eating outside of the home is from street vendors. Evidence suggests that while street vendors offer affordable food, it is often high in fat and salt.[211]

Food safety is a growing issue in low- and middle-income countries and has particular relevance at the retail level, where food sellers are often subject to safety restrictions and inspections. While it is often thought that supermarkets and other advances in retail make food safer, this is not always the case in low- and middle-income country settings.[212] The Global Panel has recently summarized the challenges and opportunities for policy makers in improving food safety at this and other levels in the food system.[213]

[207]Neven et al. (2006); Reardon, Timmer and Berdegue (2004) [208]Gómez and Ricketts (2013) [209]Bezerra et al. (2013)
[210]Lachat et al. (2012) [211]Steyn et al. (2014) [212]Blackmore, Alonso and Grace (2015); Roesel and Grace (2014) [213]Global Panel (2016b)

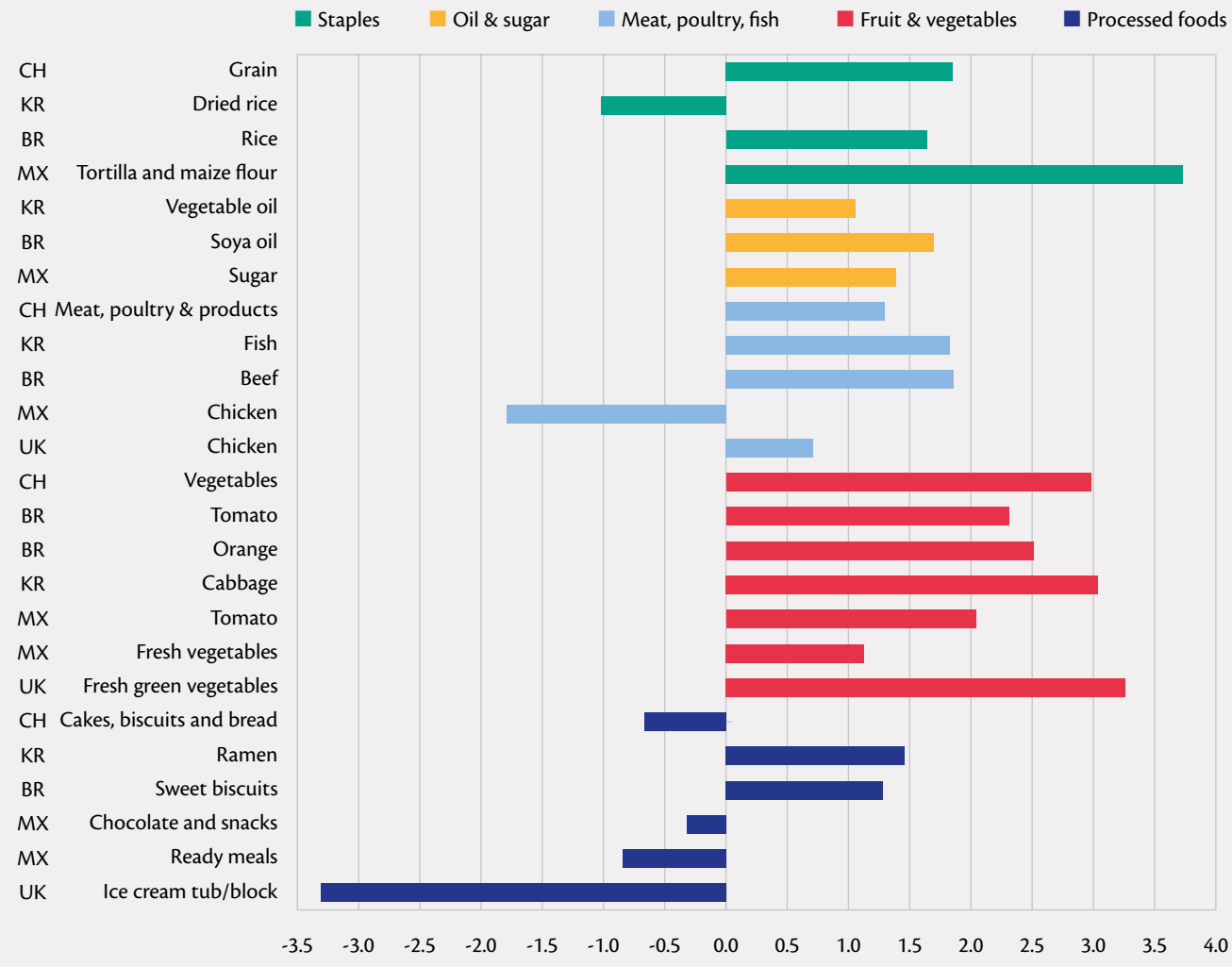
6.4 Implications

Food supply systems are complex and dynamic. Their influence on diet quality goes well beyond agricultural production into food storage, transport and trade, transformation, retail and other forms of provisioning. The influence of food supply systems on diet quality occurs via food environments i.e. what food is available and its nutritional quality, price, safety convenience and promotion. This in turn influences how available high-quality diets are to the consumer and how affordable and appealing they are.

The evidence on food systems impacts on availability appears broadly compatible with the evidence on diets. While modern food systems are providing opportunities to make foods associated with high-quality diets more available, they are also presenting barriers to greater growth; many changes have occurred which make it easier to deliver foods associated with low-quality diets more available. A critical question is the degree to which the system is supporting the delivery of high-quality diets versus lower-quality diets.

Food availability can be linked to prices and affordability. For example, the increases in cereal productivity over the past 50 years have been mirrored in their declining price.[214] Beyond farm-gate prices, consistent and comparable data on trends in food prices at point of retail are difficult to find, particularly for low-income countries. Figure 6.11 shows an analysis of changes in food prices between 1990 and 2009/12 for five high and upper-middle-income countries: Brazil, China, Mexico, South Korea and the UK. Despite the range of food systems represented by these countries, the trends are very similar. Whenever there is a significant price change, the price of fruits and vegetables have gone up in all cases, while prices of the processed foods for which data are available have gone down in four out of six cases.

FIGURE 6.11: Estimated average annual price change from 1990 in five countries



Note: CH: China; KR: Republic of Korea; BR: Brazil; MX: Mexico; UK: United Kingdom
Source: Overseas Development Institute, Figure A, Wiggins and Keats (2015)

[214] Alston and Pardey (2015)

It is not only the price level that matters for diet quality, but the volatility of prices.

One recent global review[215] on whether food prices are a barrier to the adoption of higher-quality diets by lower-income groups concluded that energy-dense foods composed of refined grains, added sugars and fats are cheaper per calorie than the recommended nutrient-dense foods and that lower-quality diets were generally cheaper (based on 151 studies). Another recent review[216] based on 27 studies from 10 countries (all high-income except for Brazil and South Africa) shows healthier meats are more expensive than unhealthy meats. This category (meats) has the largest healthy/non-healthy price differential, but there are significant cost differentials for healthy grains, oils and fats, and dairy produce. By contrast, there was no difference in the cost of soda/juice by healthy/ non-healthy categories. Studies on the affordability of nutritionally adequate diets in low- and middle-income countries are lacking. Finally, it is not only the price level that matters for diet quality, but the volatility of prices,[217] as explained in Box 6.1.

We have only considered the role of a relatively small number of elements in food supply systems that have implications for diet quality. The evidence we show is only indicative. Considerably more investment in research is needed to better understand how exactly food supply system elements are linked with concrete diet quality outcomes. Nevertheless, in line with the data presented in Chapter 2, the evidence indicates that recent trends in food supply systems are associated with both positive and negative trends for diets and that there are multiple entry points for both improving and decreasing diet quality. On the basis of available predictions, there is no evidence to suggest that future trends for low- and middle-income countries will be any different to what has occurred in high-income countries, reflecting the broader global trend in food system change. But informed and innovative policies can change food systems in a positive direction towards healthier future diets. These policy opportunities are explored in the next chapter.

Box 6.1: Price volatility and diet quality

International food prices have been more volatile after the food prices spikes of 2007–08[218] and analysts project that such volatility is likely to persist.[219] The causes of this increase are multiple, including the strengthening of links between financial, energy and food markets generated by globalization[220] and the exacerbating effect of climate change.[221] International food price volatility exerts significant influence on domestic food price volatility, especially when the volume of trade in the commodity in question is greater than 40% of its domestic production.[222]

Not all regions have seen an increase in food price volatility since 2007 (e.g. sub-Saharan Africa). But they also experience high levels of food price volatility caused by domestic factors[223] such as political turmoil,[224] poor infrastructure, weak price transmission, ineffective storage facilities and government policy that does not take enough account of – and even exacerbates – factors such as the seasonality of food prices.[225]

The poorest in low- and middle-income countries are the least able to manage food price volatility. They typically spend the over half of their incomes on food[226] and so volatility in food affordability is also affected by income volatility. Food intake and hence the diversity of diets of the poorest are most sensitive to changes in prices[227] and incomes, especially during crises.[228] They are most strongly felt for those dependent on market purchases – the urban poor and the rural net buyers of food.[229] The cost of a least-cost nutritionally adequate diet has been shown to increase and fluctuate more dramatically during times of international food price volatility in many countries, including Ethiopia, Myanmar, Niger, Tanzania and Uganda.[230]

Previous research shows that women tend to act as shock absorbers when it comes to price fluctuations[231] even though they are most vulnerable to diet shortfalls. Impacts on infants and young children will be locked in for their lifetimes and so the impacts of food price volatility on diet and nutrition are long-lived.[232] While the impacts on diet-related NCDs of food price volatility have received little research attention, some analysts suggest a strong connection via the liberalization of foreign direct investment and the stronger connections of financial and food markets.[233]

Source: Compiled by the authors

[215]Darmon and Drewnowski (2015) [216]Rao et al. (2013) [217]Global Panel (2016a) [218]Von Braun and Tadesse (2012) [219]Global Panel (2016a)
[220]Chavas, Hummels and Wright (2014) [221]Wheeler and Von Braun (2013) [222]Ceballos et al. (2016) [223]Minot (2014) [224]Pinstrup-Andersen (2015)
[225]Cornia, Deotti and Sassi (2016) [226]Von Braun and Tadesse (2012) [227]Green et al. (2013) [228]Skoufias, Tiwari and Zaman (2011)
[229]Von Braun and Tadesse (2012) [230]Global Panel (2016a) [231]Haddad et al. (1995) [232]Hoddinott et al. (2008) [233]Friel, Labonte and Sanders (2013); Hossain et al. (2015)

7 Policies and tools for diet-friendly food systems

KEY MESSAGES

- The food system presents a huge opportunity to act to improve diets. There are many possible actions that can be taken to improve diet quality with entry points in different parts of the food system. Most of these are vastly underutilized.
- Some solutions have already been tried to improve diet quality in food supply systems, but typically not widely enough. There is significant scope to improve design so they are more effective in specific contexts.
- Many policies that influence the food system have objectives other than improving diet quality, such as increasing the quantity of food supply and profitability. There is considerable scope to amplify their effects by building in diet quality objectives.
- Policies need to align the whole food system towards diet quality goals. A policy to produce more vegetables, for example, will be rendered ineffective if they are all lost or wasted before they reach consumers. Food can also be rendered unsafe through entry points in the food system.
- Policies to create diet-friendly food systems should be selected to address the diet quality and malnutrition problems in populations in individual countries, municipalities or localities. Policy design should also take account of the reality of people's lives and cultural concerns.
- Given the plethora of possible actions, how can policy makers decide which will be effective to meet local diet quality problems? A simple decision-making tool is provided to help policy makers identify which actions will help lever food systems towards diet quality goals.

7 Policies and tools for diet-friendly food systems

In this chapter we ask: What actions can be taken in food systems to maximize the positive trends towards diet quality observed in Chapter 3 and minimize negative trends? This means actions that improve food environments by making more diverse diets available and affordable to vulnerable groups. They involve making wholegrains, legumes, fruits, vegetables and nuts affordable and appealing to all, and providing meat, fish and dairy in ways that contribute to improving diet quality. Actions are also needed to minimize the availability, affordability and appeal of foods high in saturated and trans fats, salts, sugars and/or other refined carbohydrates, as well as excessive consumption of meat. To do so:

- **Changes will be needed throughout the different food supply systems and food environments**. This means looking for actions throughout food systems and aligning them towards a common objective. They include policies, investments, programmes and projects. In particular, as the private sector plays a key role in food systems, incentives and standards for businesses should be an important consideration. Every action will have a specific food system entry point.

- **Actions are needed at different scales**. Leveraging short chains and local food systems will be effective in some instances; in others influencing longer chains will be needed. In practice, a combination will be necessary. Action can also be taken at different levels of government. While national governments play a key role in policy formulation, actions can also be taken at the municipal level. There is also a role for global decision making.

There are many possible actions that can be taken to improve diet quality with entry points in different parts of the food system.

Actions are also needed to minimize the availability, affordability and appeal of foods high in saturated and trans fats, salts, sugars and/or other refined carbohydrates, as well as excessive consumption of meat.

- **Action needs to be tailored to address the diet quality problem, including new and emerging problems, at hand**. While there are common drivers and processes, the nature of diet quality problems vary spatially and demographically between different populations, as does the nature of food systems that serve these populations. While some problems may be endemic throughout national populations and caused by nationwide food system elements, in other cases solutions will be local.

- **The starting point should be an understanding of the diet quality problem and the role food systems play in influencing it**. Finding effective solutions will involve starting with the population of concern and the diet quality gap they face, examining what food systems they are served by and then working back into the food system to find the most effective, aligned solutions.

Here we illustrate a range of possible options that can be applied by policy makers. We introduce a simple but innovative decision-making tool to assist the decision-making process of identifying food system actions. The aim is to help guide the decision-making process for policy makers to follow to ensure that food systems are delivering high-quality diets.

7.1 Food systems policies for improving food environments and diet quality

In 2014, the Global Panel released its technical brief: *How Can Agriculture and Food System Policies Improve Nutrition?*[234] In it, we stress that policies across the food system (i.e. not just in agriculture) would be key to reducing undernutrition and growing overweight, obesity and other diet-related NCDs. No single policy on its own can improve diet quality and nutrition. Rather, the greatest and the most rapid improvement in diet quality will come from coordinated efforts in several different policy domains. For instance, a consumer-facing policy that promotes nutritious foods will be more successful if an agricultural policy has improved production of those foods and a market policy has improved access, making them more available and affordable in the consumer's food environment.

This in turn requires planning and cooperation across traditionally isolated parts of government and between public and private sectors. To add to this political challenge, much improvement will come from changing existing policies, which are not contributing to improving diets and to resolving incoherence between food-related policies in different parts of the food system.

In the following sections, we illustrate some actions for policy makers to consider for each of the parts of the food system. We do this to illustrate the range of possibilities, but we must stress that the most effective approach to improving diet quality will be to implement a range of coordinated policy changes, not single actions. These policy actions will not be applicable in all circumstances and are far from exhaustive. For each part of the food system, we suggest that there are three broad sets of actions, which can be used to improve diet quality via improving food environments:

- **Improving delivery of actions already tried with the goal of improving diet quality.** Some policy actions have already been taken as a means of improving diet quality. The evidence for their effectiveness is variable, but they provide experiences from which to build on and learn from. There are opportunities to improve their design and/or delivery, as well as implement more widely used lessons on what has worked well. For example, school meal programmes are implemented in many countries, but there is space for wider implementation and more effective design and delivery to meet diet quality goals and other food system benefits.[235]

- **Levering existing food systems policies towards diet quality.** There is already a plethora of policies implemented in food systems, from farm to fork. These policies have a range of different objectives, including increasing food production, supporting livelihoods and enhancing economic profitability. Most do not aim to improve diet quality, but could be modified to do so. A typical example concerns policies that are directed at food production and security (i.e. having sufficient food) but not towards diet quality.

- **Novel policy actions.** The third category is innovative policy actions that are completely novel and untested in the context of food systems and diet quality. Examples are: using mobile technology operators to host nutrition messaging as a free service to farmers in households at risk of malnutrition;[236]

Box 7.1 The Global Panel's 'top 10' recommendations

In its efforts to catalyze policy action, the Global Panel has compiled a suite of technical and policy briefs that lay out the evidence for recommendations. The 10 key recommendations that offer multiple win opportunities, from agricultural production, to markets and trade systems, food transformation and consumer purchasing power to consumer demand are listed below.

1. Invest in nutrition-enhancing agricultural productivity growth, markets and trade systems
2. Increase research to ensure a greater presence of healthy foods in markets globally, including through public-private partnerships
3. Facilitate markets and trade in ways that moderate food price volatility
4. Improve infrastructure in agriculture and market systems to increase year-round availability of nutrient-dense foods to all consumers
5. Develop national policy and regulatory framework for food safety and quality
6. Improve the nutritional quality of and consumer choice regarding processed foods
7. Integrate nutrition education into all available national services reaching consumers
8. Expand agriculture-supportive targeted social protection programmes
9. Expand agriculture-supportive school meal programmes
10. Improve the quality and specificity of metrics and data needed to support evidence-based policy actions

Source: Global Panel (2016c)

[234]Global Panel (2014) [235]Global Panel (2015c) [236]Swanson (2008); Du (2014)

requiring sales reduction targets for companies for specific foods; or developing new retail hubs for specific nutritious foods at locations and times suitable for underserved populations.

To identify these actions, we reviewed information collated by the Global Panel, WHO, FAO, NGOs, donors and governments on actions that are currently being taken. We then identified existing food systems policies with non-diet quality objectives from the evidence gathered in Chapter 6 and FAO FAPDA (Food and Agriculture Policy Decision Analysis) database. We go on to use the wider development literature as a basis on which to speculate about what could be adapted, developed and tested in the food systems policy area (Table 7.1). We also make a few "blue skies" suggestions in Tables 7.1 to 7.7 as a way of encouraging innovative thinking.

Throughout our illustrations of possible actions that can be taken by policy makers, we pay particular attention to policy recommendations already made by the Global Panel. Box 7.1 lists some of the key existing recommendations relevant to diet quality.

7.2 Entry points for policies and actions

7.2.1 Entry points in the agricultural subsystem

Improving delivery of actions that already have diet quality goals

While households buy a majority of their foods from local markets in most countries, many households vulnerable to malnutrition still produce and consume some of their own food. Deliberate efforts to improve the nutritional quality of that food are proving an important way of improving diet quality (e.g. Burkina Faso).[240] Actions that have been tried to date include urban agriculture, improving household production of nutritious crops, empowering women's control of agricultural production and biofortification. Early work to leverage agricultural production to improve nutrition outcomes[241] found that agricultural improvement generally improved diet quantity but not nutritional status. Later work found that agriculture for nutrition projects are most effective when they:

> *"invest broadly in improving human capital, sustain and increase the livelihood assets of the poor and focus on gender equality."*[242]

The most recent reviews of the evidence found that projects deliberately established to improve diet quality through agricultural production (e.g. home gardens) report increased consumption of the produced foods rich in protein and micronutrients,[243] and significantly improved diet patterns and vitamin-A intake for both women and children.[244]

The emphasis of these projects has been in rural areas. Agriculture is also practiced in cities and urban fringes by millions of households (Box 7.2). There are many positive implications of this urban agriculture for diet quality although a recent systematic review on its effects on food security, dietary diversity and nutritional status could not find a clear link, mainly because the constituent studies were poorly designed.[245]

TABLE 7.1: Policy options in the agricultural subsystem

Improving delivery of actions already tried with the goal of improving diet quality	• Urban agriculture. • Home gardens or household production of nutritious foods e.g. milk, vegetables, legumes, underutilized grains in producer households.[237] • Empowering women's access to agricultural production.[238] • Building diet behavioural change into small-scale agricultural programmes. • Breeding staple crops that have higher densities of key micronutrients such as zinc, iron and vitamin A, i.e. biofortification.
Levering existing food systems policies towards diet quality	• Redesign the agricultural research landscape to support high diet quality,[239] by reframing productivity through nutrients rather than through calories. • Balance specialization and diversification of agricultural production at the landscape level to support high-quality diets, such as crop diversification using locally adaptive varieties and adopting agroecology to develop local food systems.
Ideas for novel actions	• Mobile network operators host nutrition messaging as a free service to farmers to drive more business to their services, acknowledging that female farmers often control food acquisition and preparation. • Introduce nutrient productivity metrics that assess kg of nutrient produced per unit of land or labour.

Source: Compiled by the authors

[237]Global Panel (2014) [238]Global Panel (2014) [239]Global Panel (2014) [240]Olney et al. (2015) [241]See for example the collection of country case studies in Von Braun and Kennedy (1994) [242]The International Bank for Reconstruction and Development and The World Bank (2007) [243]Masset et al. (2012) [244]Girard et al. (2012) [245]Warren, Hawkesworth and Knai (2015)

While these various projects are playing an important role in levering the agricultural sector towards better nutrition outcomes, they are limited. For example:

- their primary focus to date has been on farm households or short chains that directly link agricultural production to local markets and on relatively small-scale projects developed in isolation from broader, powerful food system forces
- the evidence of their effects is mixed, indicating a need to focus carefully on appropriate design for local contexts and to enhance programme participation
- where they have been successful, the projects have involved more than improving agricultural production alone
- they have not focused on reducing harmful components of diets.

There is thus considerable opportunity to improve and expand on delivery of these existing actions in the agricultural subsystems, including by scaling-up, implementing synergistic changes to ensure agricultural products reach markets and vulnerable groups and complementing them with additional and novel food system policies. Biofortification is one approach with huge potential for scale-up. To further advance the potential benefits of biofortification, experience has shown that greater efforts to enhance programme participation will ensure effectiveness.[246]

Levering existing food systems policies towards diet quality

The analysis of food systems change in Chapter 6 highlights the potential entry points for attention by policy makers. Two of these are: investment in agricultural R&D and getting the balance right between specialization and diversification.

Promoting better nutritional quality is rarely the principal driver of either private or public sector R&D. With the exception of biofortification, public research is mainly guided by the goal of ensuring a reliable supply of basic staples, generating more calories and thereby meeting at least a minimum threshold of energy demand. As noted earlier, public sector research has also led to legumes research which to date has not attracted major private sector R&D. Private sector investment in research is driven by a range of different incentives, including profitability. How can the agricultural research landscape be geared more effectively towards supporting high diet quality?

One approach would to be to allocate funding to "productivity" of nutrients rather than to calories. Box 7.3 highlights the modelled impact of moving agricultural productivity towards diet quality using two sets of scenarios run using IMPACT Version 3.2.2.[247] However, we know that productivity alone will not necessarily have a direct impact on the diets of vulnerable groups. Questions need to be asked that reflect more broadly on the current focus of agricultural research on productivity and ask what type of agricultural research would help meet diet quality goals. It is possible, for example, that a greater focus of research on postharvest losses would be more beneficial than productivity research.

Box 7.2: Urban farming: The potential positives for diet quality

- Vegetables have a short production cycle; some can be harvested within 60 days of planting, so are suitable for urban farming.
- Garden plots can be up to 15 times more productive than rural holdings. An area of just 1 m^2 can provide 20 kg of food a year.
- Urban vegetable growers spend less on transport, packaging and storage and can sell directly through street food stands and market stalls. More income goes to them instead of to middlemen.
- Urban agriculture provides employment and incomes for poor women and other disadvantaged groups.

Source: FAO (2016e)

Another entry point that requires attention is the balance between production specialization and diversification. Economic theory tells us that agricultural specialization and trade, guided by a country's comparative advantage is the logical response in a rational, frictionless, shock-free world in which there is perfect information. However, in the real world, agricultural strategies need to balance specialization with diversification of cropping systems to ensure a balanced diet, addressing risk and uncertainty, build resilience and generate greater environmental sustainability. The Panel has already highlighted how emerging policy actions for climate-smart agriculture could contribute to improving diet quality through crop diversification:

> *"Crop diversification using locally adapted varieties is widely promoted as a strategy that can support the adaptive capacity of most food systems. For example, the Adaptation for Smallholder Agriculture Programme in Bolivia, has used indigenous knowledge related to climate change adaptation to support the introduction of varieties that can be grown at higher altitudes if necessary. That intervention has supported a transition from almost exclusive potato production to a more diversified portfolio that includes fruits tree production, which has increased market penetration for smallholders."*[248]

[246]De Brauw, Eozenou and Moursi (2015); Global Panel (2015b) [247]Robinson et al. (2015). The scenarios were run to 2050, using the second shared socio-economic pathway (SSP2, O'Neill et al. 2014) and assuming a constant 2005 climate. [248]Global Panel (2015a)

Box 7.3: Modelling the impact of increasing agricultural productivity of healthier foods

Under each of the productivity scenarios (Table 7.2), agricultural productivity for healthier foods (e.g. fruits, vegetables, pulses and poultry) is increased compared to the reference scenario, which assumes continuation of current trends. Increased productivity of these crops leads to greater production and a decline in world prices for these commodities. The Prod25 scenario sees an increase in productivity of about 25% and price declines for targeted commodities was in the range of 20–25% relative to the reference case in 2050. The average change in world prices for all fruits and vegetables, pulses and poultry is 22%, 22% and 24%, respectively. The Prod50 scenario which doubles the increase in productivity growth shows a near doubling in the decline in prices compared to Prod25.

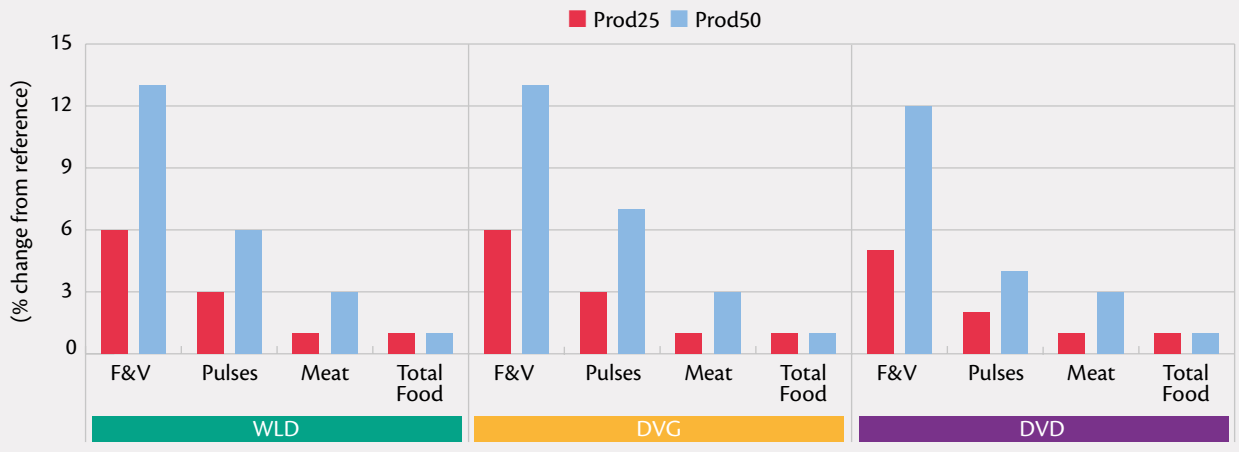
Table 7.2: Policy scenarios: Productivity

Scenario	Description
Reference	Baseline IMPACT Productivity Trends
Prod25	25% higher yields compared to reference scenario by 2050 for fruits, vegetables, pulses and poultry, phased in over 35 years in all regions starting in 2015
Prod50	50% higher yields compared to reference scenario by 2050 for fruits, vegetables, pulses and poultry, phased in over 35 years in all regions starting in 2015

Source: IMPACT Model 3.2.2 run Feb 2016

Declining prices benefit consumers, allowing them to purchase more with the same income than previously. Under both productivity scenarios, total demand for all foods increases from 1% to 2%. These increases in demand are more pronounced for targeted commodities, which see global increases of between 3% and 7% under the Prod25 scenario and between 5% and 16% under the Prod50 scenario (Figure 7.1). As all fruits, vegetables and pulses benefited from increased productivity in both scenarios, there are limited changes in the make-up of food demand within these commodities groups (and limited differences across regions); hence all of the commodities in these two groups see increases in demand.

FIGURE 7.1: Changes in food demand in calories for select food groups (f&v, pulses, meat) by 2050



Source: IMPACT Model 3.2.2 run Feb 2016 Note: WLD – world; DVG – developing countries; DVD – developed countries

Poultry is the only animal product targeted by the modelling scenarios. It sees a significant decline in prices relative to other meat commodities. This leads not only to an increase in demand for poultry (of 7% and 16% for Prod25 and Prod50, respectively), but also to substitution effects in relation to other meat commodities, which become relatively more expensive. Meat demand for beef, lamb and pork declines by about 0.5% and between 1–1.6% for the Prod25 and Prod50 scenarios, respectively. This has the additional benefit not only of increasing demand for poultry, a relatively healthy animal protein source, but also of reducing red meat demand, which is associated with a variety of negative health outcomes.

Source: Robinson et al. (2015)

The growing support for agroecology, defined as:

> *"the science of applying ecological concepts and principles to the design and management of sustainable food systems"*

– is another way through which greater diversity can be generated.[249] It is characterized by temporal diversification (e.g. crop rotation), spatial diversification (e.g. mixed farming) and encourages diversity at the plot, farm and landscape level. Agroecological approaches can be developed as part of a broader agricultural strategy that aims to balance the benefits of specialization and diversity. But as yet, these have rarely been designed with diet quality as one of the primary intended outcomes. Simply increasing production diversity will not necessarily have a direct impact on diet quality; markets are also needed for agroecology.

Along with agroecology, there is a whole range of production techniques that could be used to increase the contribution of agricultural production to high diet quality while also meeting sustainability goals.[250] Actions are needed to address food safety concerns and food waste. Staggering production cycles can, for example, be used to reduce surplus and even-out production during the year.

7.2.2 Entry points in the food storage, transport and trade subsystem

Improving delivery of actions already tried with the goal of improving diet quality

The food systems analysis in Chapter 6 identified three key entry points in the storage, transport and trade subsystem, which covers food as it moves through the system postharvest: reducing food losses and waste, addressing food safety, and rules and mechanisms on cross-border trade. While there are numerous efforts underway globally and nationally to reduce food losses and improve food safety in the postharvest system, none were identified which explicitly aim to improve diet quality.

Only a small number were identified for trade policy. Pacific Island countries, which rely heavily on imports, have imposed restrictions and tariffs on imports on foods high in fats, sugars and salt. There is an often-cited example of the Pacific Island of Samoa, which restricted imports of fatty meats in an attempt to reduce their consumption. Following accession to the WTO, this was changed to a high sales tax.[251] Another isolated example is an action by the Government of Ghana to use their food trading standards to limit the amount of fat in meat and meat cuts. While these standards apply both to domestic and imported meat, they were developed in response to rising imports of low quality.[252] The standards limit the amount of fat in specific meat cuts.

Levering existing food systems policies towards diet quality

Many policies that influence food storage, transport and trade have considerable potential to be redesigned through a diet-quality lens. In food storage and transport, many efforts to reduce postharvest losses still focus on cereals.[253] Yet training, capacity building and technologies to reduce waste could play a key role in enhancing the availability and affordability of a greater diversity of crops where spoilage levels are relatively high, such as fruits, vegetables and legumes. Simple measures like the use of returnable plastic crates have been proposed as effective.[254] Waste reduction also aligns well with the need to reduce use of scarce natural resources and cut greenhouse gas emissions.[255] Policies on transport of food could also focus on transport infrastructure to ensure poorly served communities have access to better quality diets and cool chain technologies where they present bottlenecks for availability and access.[256]

Actions can also be taken to improve food safety. The Global Panel has highlighted the urgent need to:

> *"Promote improved knowledge and practices related to on-farm storage of agricultural products known to be prone to food safety hazards. Numerous innovations in materials, for example, in storage bin and sack technology, should be explored and promoted in the relevant context."*[257]

For example, it is evident that during storage, better drying and storage facilities are needed to prevent and control aflatoxin contamination of maize and groundnuts.

Existing food and agricultural trade policies vary widely between countries. In some countries, governments allocate major roles to public institutions to manage markets, such as through strategic infrastructure investments, the setting of commodity prices, managing publicly-held buffer stocks, distributing commodities to targeted populations and levying import tariffs on foods. In contrast, trade policies in other countries focus largely on providing a legal and regulatory framework with which private marketing agents must comply, such as those linked to food safety and labelling of food quality.[258] In all cases, diet quality has not been seen as a primary outcome and food security has played a more central role. Despite the tensions around trade policy at the international scale, considerations of diet quality should be brought into these negotiations and opportunities taken to build capacity for this process.[259] Good diagnosis is needed to ensure coherence between trade policies and diet and complementary policies implemented to enhance the synergies and manage the risks of trade policy for diet quality.[260] A critical question is what complementary policies are needed as part of the package of trade reforms to ensure that the benefits of trade policies are transferred to the people who most need them and to mitigate the risks?

[249]Gliessman (2007) [250]Gladek et al. (2016) [251]Thow et al. (2014) [252]Thow et al. (2014) [253]Affognon et al. (2015) [254]Kitinoja (2013)
[255]Global Panel(2015a) [256]Global Panel (2016b) [257]Global Panel (2015b) [258]Global Panel (2016a) [259]UNSCN (2015) [260]UNSCN (2015)

A range of actions could be taken to make trade policy more coherent with diet quality outcomes. Regional trade of nutritious foods is perhaps an underutilized space to fill diet gaps.[261]

Existing trade mechanisms could be used, such as redefining sanitary and phytosanitary measures (SPS Agreement) to incorporate diet considerations, leveraging aid for trade initiatives to support domestic production of nutritious foods and using the Codex Alimentarius Commission (Food Code) for international guidelines. For example, the World Trade Organization (WTO) Aid-for-Trade initiative or Enhanced Integrated Framework (EIF) Aid-for-Trade partnership could be used to increase the supply of fruits and vegetables in low-income countries and diet goals could be taken into account in the design of Diagnostic Trade Integration Studies in low-income countries. Codex could be used to set international standards for consumer-friendly nutrition labelling and ensure SPS standards support diet quality considerations.

7.2.3 Entry points in the food transformation subsystem

Improving delivery of actions already tried with the goal of improving diet quality

Two of the entry points in the food transformation subsystem have been relatively widely implemented to explicitly improve diet quality: fortification and reformulation. Both these approaches are examples of using public policy to leverage private sector action to improve the nutritional quality of their products.

Many populations and age groups do not get enough of the recommended nutrients they need through the food they eat. This may be because they lack the income to buy a diverse diet, they lack the knowledge about the value of a diverse diet or it is too inconvenient to access such a diet. The fortification of certain foods (biofortification) is one pathway towards improving the micronutrient intake of these groups.

The what, who and how of fortification is very context-specific. Working through small-, medium- and large-scale industry to fortify wheat, rice, sweet potatoes, salt and sugar with elements such as zinc, iodine, vitamin A and iron, fortification can be an effective intervention for key vulnerable groups (e.g. those on low incomes with a monotonous diet, those with illness, those with particularly high nutrient requirements, pregnant and lactating women and young children).[262] The public sector needs to set the nutrition priorities and the nutrient thresholds and monitor the safety and compliance of fortification with standards.

Fortification should not be thought of as a substitute for a well-balanced and diverse diet, but rather as a complement. The need for fortification should decline as diet diversity increases, as education levels improve and as families move from belonging to low- to middle-income households. There will still be vulnerable groups with particularly high nutrient requirements that will at certain times require the consumption of fortified foods. The Global Panel has already recommended that for effective fortification, public–private partnerships are needed to set appropriate standards, establish monitoring mechanisms, and investigate new ways to process and package nutrient-dense but affordable, complementary infant food.[263]

Another entry point that has been relatively widely tried is reformulation of processed foods i.e. the process by which food manufacturing companies remove, reduce and/or substitute one ingredient for another in a processed food. Reformulating to reduce salt content has now become one of the most widespread public policies to promote higher-quality diets.

TABLE 7.3: Policy options in the food storage, transport and trade subsystem

Improving delivery of actions already tried with the goal of improving diet quality	• Using tariff levels (within bounded limits) to influence imports of different foods in small island states dominated by imports. • Use trading standards for food composition to improve nutrient quality of specific foods.
Levering existing food systems policies towards diet quality	• Train, build capacity building and adopt technologies to reduce postharvest waste of nutritious crops. • Invest in techniques to reduce postharvest contamination. • Investing in transport and cool chain infrastructure where they prevent blockage for availability and access to poorly served communities. • Safeguards to prevent distortions that discourage local production and regional trade in nutritious foods such as legumes and underutilized grains. • Integrating diet quality into trade negotiations around food security. • Ensuring coherence between trade policies and diet quality, including through implementation of complementary policies. • Leveraging Aid-for-Trade initiatives to support domestic production of nutritious foods. • Redefine sanitary and phytosanitary standards (SPS Agreement) to incorporate diet considerations.
Ideas for novel actions	• Develop innovative, community-based postharvest technologies to preserve surplus nutritious foods for sale in local markets throughout the year. • All food-trading partners are obliged to show how their trading practices will help to promote higher-quality diets

Source: Compiled by the authors

[261]Hawkes, Grace and Thow (2015) [262]Bhutta et al. (2013) [263]Global Panel (2014)

At least 75 countries have developed salt reduction strategies, 60 or more involve engaging with industry to reformulate products.[264] The process involves identifying the largest sources of salt in processed foodstuffs and gradually reducing salt levels over time. Many such interventions have been shown to be successful in reducing salt intakes. While most initiatives are voluntary, the governments of Argentina and South Africa are now increasingly imposing mandatory salt limits. Legislative approaches have also been taken to reduce trans fats.[265] These restrictions have been universally successful in reducing trans fats levels.[266]

But, for both salt and trans fats, there has been far less activity in low- and lower-middle-income countries. For example, while there are 40 high-income and 21 upper-middle-income countries reportedly pursuing such measures, only 11 lower-middle-income countries and a single low-income country have put a salt reduction strategy in place.[267] Given the proven effectiveness of these strategies, improving delivery involves wider implementation.

Policy entry points are also available, which aim to change food environments that need to be implemented by the actors in the food transformation subsystem. These include: health-related food taxes, nutrition labelling and restricting advertising and marketing of processed foods to children. Changing affordability though taxes is an approach that has proved effective in Mexico[268] and is being more widely implemented – at least 11 countries have health-related food taxes. Box 7.4 illustrates the effects of a health-related food tax using the IMPACT model.[269]

Nutrition labelling is also relatively widely implemented and aims to provide information to consumers, either by providing lists of nutrient content or more graphical approaches giving "traffic light" colours for the levels of different nutrients. The evidence suggests the main influence on diet quality is through encouraging reformulation.[270] Another approach is through restricting marketing of (often ultra-processed) foods high in fats sugars and salt to children, which has been, to date, implemented in only a small number of countries. The aim is to reduce the appeal of these foods to children, though potentially it could also have impact by reducing the incentive for food manufacturers to produce these products in the first place.[271]

To improve delivery of these actions, more need to be implemented in low- and middle-income countries. To date these approaches been far more widely implemented in higher-income countries although it is the lower-income countries where growth rates of sales of ultra-processed foods are growing the fastest.[272] This is partly because of opposition to their implementation from the private sector.[273] They also need to be carefully designed and their impact better evaluated.[274] As already pointed out by the Panel,

TABLE 7.4: Policy options in the food transformation subsystem

Improving delivery of actions already tried with the goal of improving diet quality	• Food product reformulation • Labelling • Restrictions on advertising and other forms of promotional marketing • Health-related food taxes
Levering existing food systems policies towards diet quality	• New primary processing technologies to reduce costs and enhance consumer acceptability of nutritious foods. • Corporate tax rates banded to incentivize healthier food production and processing. • Investment fund for start-up SMEs producing recommended foods.
Ideas for novel actions	• Investment conditionalities placed on food companies to meet sales reduction targets of foods that undermine high diet quality.

Source: Compiled by the authors

"There are few data on how the private sector is influencing diets and diet quality through food processing, fortification, marketing and pricing. Policy makers need a much better understanding of the growing role of commercial food transformation as it influences what the majority of the world's citizens are already eating."[275]

Levering existing food systems policies towards diet quality

Chapter 5 shows that food processing originated with the need to enhance the quantity of food available, to preserve it through seasons and to make it safe, but in more recent years, the focus has shifted towards producing foods more quickly and profitably. How can this approach be oriented towards diet quality? One option is to improve the basic processing of recommended foods. Legumes are a good example. Improved technologies to reduce milling losses and enhance product quality together with the development of fast-cooking bean flours could act to enhance availability, affordability and appeal to consumers.[276]

Existing policies on industry investment often encourage inward foreign, as well as domestic, investment in food processing. A way of reorienting this approach would be to provide incentives for "diet quality" investments and strategies to encourage an entrepreneurial economy for high-quality diets. Corporate tax rates could for example be banded to incentivize healthier food production and processing. Or competition law could be used to lower barriers to entry for food companies that meet certain conditions in terms of the health effects of their products.[277] Investment funds for healthy start-ups and small-scale, local-level processing of nutritious foods could also be provided.

[264]Trieu et al. (2015) [265]WCRF (2016b) [266]Downs et al. (2015); Hendry et al. (2015) [267]Trieu et al. (2015) [268]Colchero et al. (2015) [269]The International Model for Policy Analysis of Agricultural Commodities and Trade (IMPACT) was developed in the early 1990s to consider the long term challenges facing policy makers in reducing hunger, and poverty in a sustainable fashion. It is a network of linked economic, water, and crop models. [270]Hawkes et al. (2015) [271]Hawkes et al. (2015) [272]IFPRI (2016a); WCRF (2016b) [273]Roberto et al. (2015) [274]Hawkes et al. (2015) [275]Global Panel (2015d) [276]Mazur et al. (2012) [277]De Schutter (2010)

Box 7.4: Modelling the effect of health-related food taxes on diet quality

The tax scenarios differ from the productivity scenarios in that they suppress demand, by increasing the domestic price that consumers face on oils and sugar. The global effects of this intervention lead to a decline in demand. Table 7.5 outlines the two policy scenarios we model and Figure 7.2 summarizes the outcomes of the scenarios.

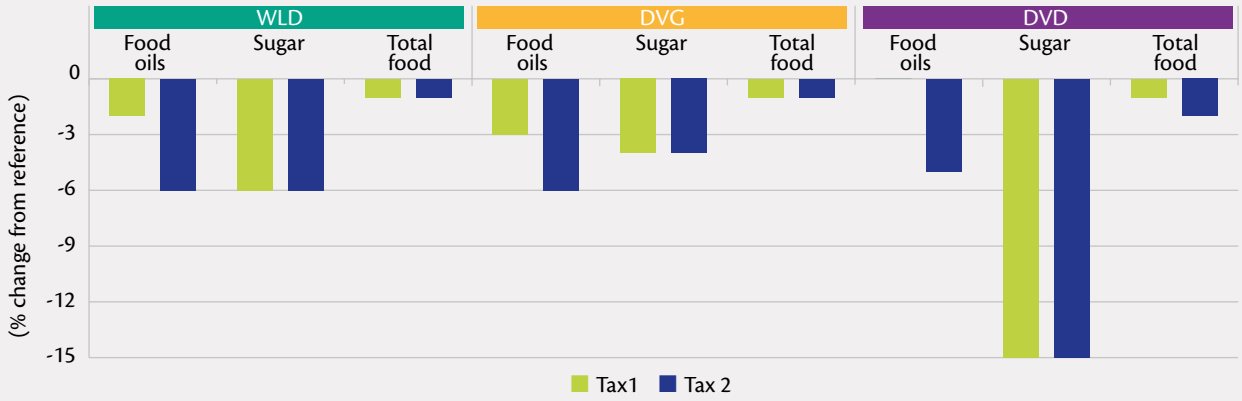
TABLE 7.5: Policy scenarios: Taxes

Scenario	Household food taxes
Tax 1	Decline in baseline consumer support estimates (CSEs) by 20 percentage points implemented in 2015 in all regions for palm fruits oil, palm kernel oil and sugar
Tax 2	Decline in baseline CSEs by 20 percentage points implemented in 2015 in all regions for all food oils and sugar

Source: IMPACT Model 3.2.2 run Feb 2016

Globally, the demand for sugar declines by about 6% under Tax 1 and Tax 2. The demand for all food oils is diminished, but more for Tax 2 (all oils) than for Tax 1 (only palm oil). Tax 1 shows how overall food security can be protected (vegetable oil consumption is diminished only slightly) while health can be improved as consumers switch from palm oil to healthier forms of vegetable oils.

FIGURE 7.2: Changes in food demand in calories for select food groups (food oils, sugar) by 2050



Source: IMPACT Model 3.2.2 run Feb 2016 Note: WLD – world; DVG – developing countries; DVD – developed countries

Source: Robinson (2015)

7.2.4 Policies with primary entry point in food retail and provisioning subsystem

Improving delivery of actions already tried with the goal of improving diet quality

There are a large number of potentially powerful entry points in the food retail and provisioning subsystem, most of them vastly underused (Table 7.7).

There is a rapidly growing interest in short-chain "local food systems" involving direct marketing from farmers to customers. These systems involve new models of retailing as well as the restructuring of supply chains and are often developed to improve access to more nutritious foods.[278]

Another set of actions involves providing incentives to retailers to make better quality diets available and reduce the appeal of lower-quality diets, an approach that has been tried in high-income countries. For example:

- In the United States, in February 2014, the US Congress formally established the Healthy Food Financing Initiative (HFFI) in which states use funds to incentivize retailers to sell nutritious foods in underserved areas.[279]

[278]IPES-Food (2015) [279]WCRF (2016a)

- In Singapore, the "Healthier Dining Programme" launched in June 2014, offers food operators who offer lower calorie meals and use healthier ingredients such as oils with reduced saturated fat content and/or wholegrains, a certification to attract consumers.

Retailers are also in a powerful position to make changes in the way they sell, position and promote food. For example, in the US, a range of experiments have been tried which change the "choice architecture" within retailers, so making foods high in fat, sugar and salt less appealing.[280]

In food provisioning, an action that has been tried and tested is public procurement into settings such as schools, hospitals and prisons. The most notable example is "home-grown school feeding". These approaches, where food served in schools is procured from local and/or family farmers can have multiple food system benefits by establishing stable markets for producers while serving more recommended diets to children.[281]

The food service environment is another critical entry point. For example, cities in Brazil, such as Belo Horizonte and Curitiba, have established what are known as "popular restaurants" which provide meals for all local citizens at affordable prices.[282]

Food at work is another entry point. The private sector also has an important role to play here by providing nutritious meals in workplaces through "food at work" programmes and the provision of regular meals. Developing "home-grown work feeding" would be a novel way to build in what has been learned from public procurement for food in schools.

The considerable potential for the food retail provisioning subsystem for diet quality appears very underutilized. Improving the delivery of these actions involves wider implementation. It will also involve greater consideration of diet quality goals. For example, historically, the development of public procurement programmes in low- and middle-income countries has been focused on the provision of adequate calories. In high-income countries and some low- and middle-income countries, efforts have been underway for some years to refocus on diet quality. Yet many low- and middle-income countries do not yet use food and nutrient-based standards to guide their food procurement. Consumer engagement will be needed to ensure that the changes meet their needs.

Levering existing food systems policies towards diet quality

Another entry point is through informal and traditional markets and street vendors, which are a source of food for many vulnerable groups, including foods such as fruits, vegetables and ASF.[283] Yet policy in low- and middle-income countries to date on these retailers has rarely been focused on diet quality. Investment to ensure the competitiveness of this sector to help make nutritious foods accessible and affordable to local populations could strengthen them in the face of competition from supermarkets.

Food safety policies in the informal sector are a related opportunity. Most existing policies are directed towards formal market structures, such as growing supermarkets. This large, heterogeneous, informal food sector with millions of disorganized, largely untrained and unmonitored factors, makes it difficult to assure food safety. The ability to identify unsafe food or inflict market or legal penalties on those who sell it is relatively low. Direct efforts to enforce food safety standards could result in both a loss of nutritious food sources and a loss of livelihoods for the poor. There is also evidence that, if properly supported, informal markets can provide food that is at least as safe as that from supermarkets.[284] In these contexts, participatory approaches that engage informal food traders and vendors directly, offer some potential.[285]

TABLE 7.6: Policy options in the food retail and provisioning subsystem

Improving delivery of actions already tried with the goal of improving diet quality	• Local food systems with direct farm-consumer marketing • Food provision in the public sector ("public procurement") e.g. home-grown school feeding, "popular restaurants" • Private procurement e.g. food provision in workplaces • Incentivizing location of private sector retail selling nutritious foods in locations convenient to households
Levering existing food systems policies towards diet quality	• Investment in wet markets that make nutritious foods accessible and affordable • Reorienting food safety policies to support informal and wet markets • Price incentives for street vendors to use healthier ingredients • Planning regulations to support wet markets and informal retailers that provide perishable foods to low-income populations
Ideas for novel actions	• Favourable agreements for small traders at wet markets in return for guaranteeing food safety • Invest in sanitary local environments as a direct incentive to encourage informal traders and street vendors to sell perishable, nutritious foods • Developing new retail hubs for specific nutritious foods at locations and times suitable for underserved populations

Source: Compiled by the authors

[280]Bucher et al. (2016) [281]Global Panel (2015c) [282]Rocha and Lessa (2009) [283]Gómez and Ricketts (2013); Roesel and Grace (2015)
[284]Grace (2015) [285]Global Panel (2016b)

7.3 Aligning actions for coherence across food systems

There is clearly a wide range of options available to create more diet-friendly food systems. We have illustrated a small number here. In order that they deliver diet quality to people, including underserved households, they need to be implemented in an aligned manner across the food system. Changing food systems for better diets is likely to fail if decisions make changes in only one subsystem that is then undermined by lack of alignment in others. Policies should aim to create alignment (coherence) within food systems and between food systems and diet objectives.

We show examples of how this could be done in the examples in Table 7.7, which plots the range of different policies across the subsystems aligned to achieve specific dietary goals.

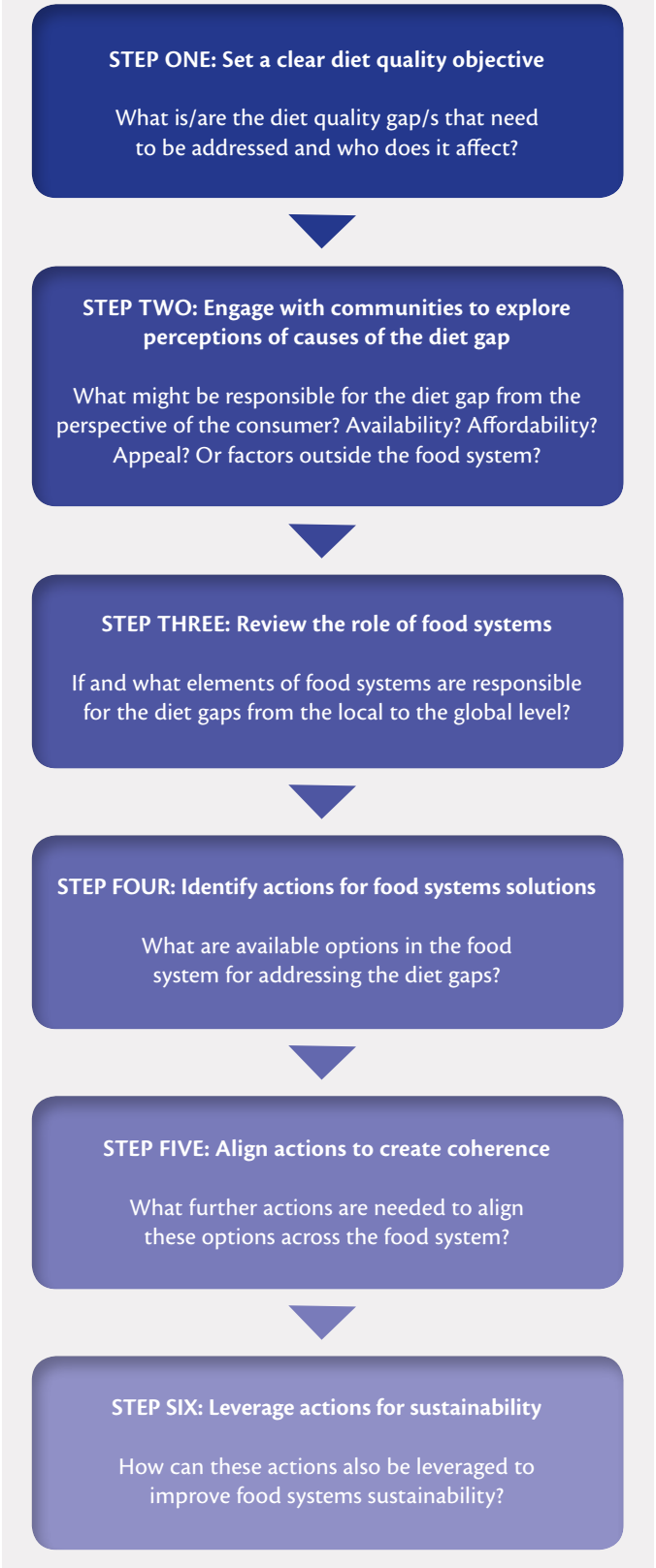
TABLE 7.7: Aligning actions across food supply subsystems to create healthier food environments for higher-quality diets

Diet goal	Agricultural production	Transformation	Storage, transport and trade	Retail and provisioning
Increase fruit and vegetable intake	Invest in mixed and integrated cropping systems to produce production diversity in areas where markets are poorly developed; where markets are developed invest in fruits and vegetable production using global funding mechanisms (see column 4)	Develop micro-enterprises for local processing to reduce waste	Leverage the World Trade Organization (WTO) Aid-for-Trade initiative or Enhanced Integrated Framework (EIF) Aid-for-Trade partnership to invest in production (column 1) in low-income countries	Invest in "wet market" infrastructure to enable maintenance for low-income groups; increase capacity for food safety among traders
Increase intake of legumes/ pulses	Agricultural research into new varieties to boost yield	Develop fast-cooking bean flours	Train farmers in management practices to reduce loss to insect damage; safeguards to prevent distortions that discourage local production and regional trade in legumes	Food price subsidies for legumes where consumption is low
Increase intake of grains high in protein, micronutrients and fibre	Incentivize the production of underutilized grains	Develop more efficient threshing and milling technologies for underutilized grains; develop novel foods with underutilized species	Ensure policies support open regional trade where neighbouring countries produce underutilized grains	Set standards and marketing incentives for use of wholegrains in processed food products
Encourage balanced consumption of safe milk	Improve availability of animal health services and ensure women have access to animals	Train milk processors in food safety and quality assurance	Invest in infrastructure to ensure safe transport of milk from farm to retail	Establish milk retail hubs are open for trading at times and locations convenient for women; provide meals containing milk in workplaces where women work
Replace trans fats with unsaturated fats	Encourage cooperatives between trans fat-free oil producers to lower prices	Prohibit public investment and disincentivize private investment in facilities producing hydrogenated oils	Lower tariffs on trans fat-free oils relative to oils containing trans fats	Create an incentive for street vendors to use trans fat-free oils through use of a "healthier oil" sign
Reduce intake of sugary drinks	Horticulture producers donate fruits that do not meet quality standards for the production of fruit juices, thus potentially lowering costs	Reformulation to reduce sugar and salt content; creating incentives for sugary drinks companies to meet sales reduction targets of sugary drinks and increase sales of pure fruit juices	Codex Alimentarius Commission sets international guidelines for consumer-friendly nutrition labels including sugar warnings on sugary drinks	Sugary drink taxes

Source: Compiled by the authors

7.4 How do we decide what actions will be effective? A decision-making tool

FIGURE 7.3: Six steps to identify policy actions to achieve healthy diets



How can policy makers decide what actions will be effective to meet local diet quality problems? How can they be prioritized? The range of possible policies set out above provides an idea of a few of the broad spectrum of actions available. But not all will be appropriate and effective for local contexts. What will be appropriate and effective depends on the nature of the problem, population and actors involved. They may also need to be accompanied by policies that address household characteristics.

Here we provide a simple but innovative decision-making tool to aid decision making (Figure 7.3). The tool is made up of a simple six-question decision tree and includes two key innovations. First, it focuses on diet quality as an outcome, focusing on the "gap" between what people are eating and the high-quality diets that reduce malnutrition and promote health. This requires an understanding of the current quality of diet of a given population, to compare with appropriate and up-to-date food-based dietary guidelines (FBDGs). This may be challenging for governments that lack data on current food consumption and/or established FBDGs. This is a critical issue we will come back to in the recommendations section of this report.

The decision tool then uses these specific dietary gaps to identify solutions that are effective and aligned to address them. The process involves working backwards through the food subsystems, taking the population and food systems characteristics into account, to identify realistic actions that could address the gaps.

In Box 7.5, three examples of using this decision tool are given for policy actions in different contexts and at local and national levels; thereby, providing more detail on three of the examples in Table 7.7.

Box 7.5: Illustrative examples of using the food systems tool to identify effective actions to improve diet quality

Local level (rural)

In ***Step One***, local diet data indicated that low-income women in rural areas experience high levels of micronutrient deficiencies and have diets low in dairy and eggs compared to higher-income women. Dairy is thus identified as the diet gap. ***Step Two*** shows that low-income women are aware of the importance of consuming these foods for their health, but cannot afford sufficient amounts. They no longer produce the products themselves due to export-oriented employment outside the home; the informal stores that make these products available are not conveniently accessible to women working long hours outside the home. In ***Step Three***, a food systems assessment shows that lack of infrastructure for distributional logistics and lack of capacity for assuring a safe milk supply reduces incentives for informal retailers selling affordable dairy to locate in places more convenient to women. Women also face barriers in producing it because of lack of support services and cultural attitudes around women's access to milk-producing animals. The retail and agriculture subsystem are thus identified as critical entry points. Options in ***Step Four*** for addressing these gaps include a food-at-work programme provided by the women's employer; it has the capacity and yet provides no food on-site, despite knowing that the women experience dietary inadequacy. Another option would be to establish retail hubs selling milk at times and locations convenient for the women, whose limited free time is taken up largely by work. Given lack of employment is one of the local challenges, a further option would be to support production of dairy products by women e.g. by ensuring women's access to animals and the provision of animal health services, In ***Step Five***, aligning the whole supply system would involve ensuring capacity for safe milk throughout the supply chain. ***Step Six*** would involve identifying any synergies for sustainability.

Municipal level (urban slum)

In ***Step One***, data indicate that nutritional status in urban slums ranges includes both stunting and obesity. Micronutrient deficiency is rife while obesity is high. A diet assessment reveals exceedingly low levels of fruit and vegetable intake and excessive consumption of trans fats from low-quality meat products from street food, often served with reused oil. The diet goal is thus to increase consumption of fruits and vegetables and decrease the consumption of fats. In ***Step Two***, it is evident that these populations are generally poor, have few, if any cooking facilities at home and experience poor sanitation, leading to high rates of diarrhoea and risk of foodborne disease. A food system assessment in ***Step Three*** shows that in the provisioning and retail subsystem, street vendors are unwilling to sell fruits and vegetables due to food safety risks from poor sanitation. Foods are deep-fried in oil high in trans fats as a means of managing these risks. In the agricultural subsystem, shortage of land means there is no opportunity for establishing local fruit and vegetable supplies or household production, while imports of very low-cost vegetable oils make purchasing large quantities of oil very cheap. In ***Step Four***, potential options in the food retail subsystem include: capacity building in food safety among street vendors and in wet markets for making fruits and vegetables available and creating an incentive for street vendors to use trans fat-free oils through a "healthier oil" sign. In ***Step Five***, to align to create coherence in other subsystems, given the critical role of oil imports, lower tariffs could be placed on healthier oils relative to oils with trans fats while also encouraging cooperatives between trans-fat free oil producers as a means of lowering prices. Policy makers could prohibit public investment and disincentivize private investment in facilities producing hydrogenated oils. ***Step Six*** involves identifying synergies for sustainability.

National

In this country, data collated for ***Step One*** indicate obesity is rising rapidly throughout the country in both urban and rural areas. A diet assessment reveals that the sales of sugary drinks and sweet snacks have risen significantly in the past decade. Sugar intake in children and adults is significantly above the 5–10% daily calorie intake as recommended by the WHO. Given that sugary drinks are the largest single contributor of sugar intake in the country, the focus is on reducing the intake of sugary drinks. As pure fruit juice consumption is very low, a related objective is to increase the intake of pure fruit juice. A review of consumer attitudes in ***Step Two*** shows that soft drinks are very popular as they are more widely available than water, which is usually avoided as it is perceived as being unclean. Soft drinks are also perceived as affordable relative to pure fruit juices as well as to drinks with non-caloric sweeteners. There is generally low awareness that sugary drinks cause weight gain and tooth decay and no indication on the labels of the drinks that they carry these risks. ***Step Three*** shows that large transnational brands have taken advantage of an open trade investment regime and placed significant investments in new bottling plants. The main ingredients of sugary drinks, sugar, is produced nationally and obtained by soft drinks manufacturers at low cost. There is further downward pressure on prices due to an open trade regime for high-fructose corn syrup, an alternative caloric sweetener. Alternative non-caloric sweeteners are also available but at higher cost. In addition to large transnational brands, local "b-brands" are also available at lower cost. ***Step Four*** reveals a whole range of options available through the food system. Changing the affordability of sugary drinks in food environments at the point of retail and applying a sugary

drinks tax is one. In the trade subsystem, the international food code which sets standards for international trade, the Codex Alimentarius (the Food Code), could be used to set standards of labelling for sugary drinks. In the food transformation subsystem, there are opportunities to reduce the sugar content of drinks as well as encouraging innovation by creating incentives for sugary drinks companies to meet sales reduction targets of sugary drinks and increase sales of pure fruit juices. Aligning to create coherence in ***Step Five*** would involve creating disincentives for the use of sugar throughout the supply chain. ***Step Six*** involves identifying synergies for sustainability.

Source: Compiled by the authors

7.5 Implications

The food systems policy space is complex but it can be navigated with careful diagnosis and a framework for selecting actions appropriate to context. Not all the solutions will be in the food system but many will. There are many as yet untapped opportunities. There are many examples of food systems approaches that have already been tried to improve diet quality. However, several of these have not been sufficiently widely implemented and careful design is needed for all of them to be effective. More and better evaluation of these approaches is required to see the effects they have and how they could be improved.

Some of the more powerful levers are food system policies that have been implemented for decades with the aim of improving quantity of output, as well as income and profit. Questions need to be asked about how to redesign these approaches to alter the incentives for food systems actors to produce better diets. There are also possibilities to develop completely novel, innovative approaches to improving diet quality. The tool we present can help prioritize and select the most effective approaches: attention to good diagnosis is key. The policy scenarios illustrate clearly that the gains could be very substantial.

Governments need to look across food system objectives and at broader goals and constraints related to the environment and social equity if better nutrition for all is central to its policy design. In particular, the need to build sustainability into a country's agricultural system, conserve limited water supplies and promote long-term management of soils, forests and biodiversity should be a priority.

Credit: John Ferguson, Oxfam

8

A call to action

KEY MESSAGES

- **The proportion of the world that is suffering from diet-related malnutrition stands at just over one in three. If current trends continue, it will move towards one in two.**
- **Currrent trends do not have to continue. They can be redirected towards reduced malnutrition through better diets.**
- **This process will require focused, determined and sustained action from policy makers working in a complex context.**
- **This report is intended to provide policy makers with a guide to what they can do – and why they need to do it.**

8 A call to action

8.1 Nutrition – a new global priority

Agriculture and food systems must deliver much more than food – they need to fulfil their potential to underpin the health and well-being of populations. At a fundamental level, consumers are making food choices that are not consistent with good nutrition, health and well-being. And public policies or private sector actions are not adequately aligning food systems toward the goal of improving nutrition.

Diet quality is the number one risk factor contributing to the world's disease burden. So at a global level, stakeholders need to prioritize the improvement of nutrition – and the consumption of the healthy diets that promote it. While the Sustainable Development Goals have put ending hunger, achieving food security, improving nutrition and promoting sustainable agriculture high on the global agenda, the absence of diet quality is a serious omission. However, the 2016–2025 UN Decade of Action on Nutrition provides many potential opportunities to place the improvement of diet quality through food systems at the centre of global action.

The international community needs to step up and accord the goal of healthy diets to all, and extend the same level of focus and commitment that it gave to addressing HIV/AIDS, and smoking. This will require stakeholders from governments, civil society, the media, business and research to work together to make improving dietary quality a sustained political priority. Strong campaigns and accountability mechanisms need to be put in place to build commitment and ensure it leads to implementation and impact.

At the national level, governments and private sector actors need to work together to focus on aligning individual food systems with the goal of attaining healthy diets and improved nutritional outcomes. This will require, amongst other actions, creating incentives for private sector actors throughout the food system so that they can make decisions more favourable to the adoption of higher-quality diets. If safe and nutritious food is not available, affordable or deemed desirable, then consumers will not acquire it and their health and livelihoods will suffer as a consequence.

It will be critical for governments to look across both food system objectives and broader goals and constraints including the need to build sustainability into the country's agricultural system, conserving limited water supplies and promoting long-term management of soils, forests and biodiversity. In particular, careful consideration needs to be given to the relationships between diets that are high quality from a nutritional perspective, and their potential impacts on the environment. These are more complex than popularly assumed, and are likely to differ considerably in different contexts.

Effective evidence-based policy making should be supported by use of appropriate analytical tools. Policy makers need to work throughout the food system to effect diet change. The methodology set out in Chapter 7, embodying a six stage process from setting diet quality objectives through to identifying and aligning actions throughout food systems, provides a systematic approach that is recommended for use by policy makers.

Non-business stakeholders need to work harder with business stakeholders to find innovative solutions to providing food that is nutritious, safe and affordable, especially to those on lower incomes. Ways in which the public and private sectors can collaborate to lower the costs of scaling-up low-cost institutional, technical or infrastructure innovations need to be found.

In making these changes, stakeholders will need to change the way they think about food systems. They are not merely for feeding people but for nourishing them well – food systems are in effect health production systems. This change in mindset is subtle but crucial.

Finally, this report has highlighted the fact that the long path that high-income countries have taken to manage rising obesity rates has not succeeded. That same path is not an inevitable one for low- and middle-income countries. There are alternatives, provided the right choices are made now and throughout the food system. The challenge for policy makers in low- and middle-income countries is to find more direct and less damaging dietary pathways from where their diets are today, to where they need and want to be. South Korea is a good example of a country that has gone from low- to middle- to high-income levels in the past 30 years in a way that has supported the supply of relatively accessible and affordable high-quality diets. It is no coincidence that this country has implemented many food system policies that aim to promote health.

8.2 Specific priorities for action

While most actions to improve food systems and diets will depend heavily on local contexts, the following are universally applicable:

1. **Focus food and agriculture policies on securing diet quality for infants and young children.** These are woefully inadequate in many countries. Improved policy choices are needed which recognize the centrality of high-quality diets for the youngest.

2. **Improve adolescent girl and adult women's diet quality as a priority in all policy making that shapes food systems.** Women are particularly vulnerable to the health impacts of low-quality diets because of their higher nutrition requirements and because of their disempowerment in some cultures.

3. **Ensure that food-based dietary guidelines (FBDGs) guide policy decisions to reshape food systems.** FBDGs are largely absent in low-income countries (present only in 2 out of 31) and limited in lower-middle-income countries (12 out of 51). They are needed to inform and to influence food policies around the world.

4. **Animal source foods (e.g. dairy, eggs, fish and meat) provide important nutrients. Policy support for these foods should be pragmatically evidence-based rather than driven by ideology.** Infants, children, adolescents and women of reproductive age living in low-income contexts will find it extremely hard to meet nutrient requirements in the absence of these foods. At the same time some groups in low-income contexts are consuming levels of these foods in excess of recommended levels.

5. **Make fuits, vegetables, pulses, nuts and seeds much more available, more affordable and safe for all consumers.** They offer considerable benefits in terms of diet quality. There are opportunities throughout the food system to overcome supply-side barriers to make them available, affordable and appealing. Public policy can also incentivize greater investment in the infrastructure required to produce, store and transport these foods.

6. **Make policies which regulate product formulation, labelling, advertising, promotion and taxes a high priority.** These are needed to create disincentives for companies to allocate resources to forms of processing that undermine diet quality. Policies to educate consumers of the adverse health effects of consuming these products more than occasionally are also needed.

7. **Improve accountability at all levels.** Governments committed to reshaping food systems toward healthy diets need to set targets and publish transparent scorecards of their results. Private sector actors should acknowledge their far-reaching roles in defining food environments – and the nutritional quality of foods and other products that they promote to consumers. Civil society organizations need to monitor the performance of others.

8. **Break down barriers associated with the longstanding division of jurisdictional responsibilities within many governments – between agriculture, health, social protection and commerce.** These can fundamentally impede integrated action across food systems, inhibit the effective allocation of resources and create barriers that inhibit access to data.

9. **Institutionalize high-quality diets through public sector purchasing power.** Food provided in schools, hospitals, across the armed forces and in the prison system should be of the highest dietary benefit to the consumer. This approach has the potential to shape the norms around foods that contribute to high-quality diets and incentivize suppliers and contractors to align their value chains accordingly.

10. **Refocus agriculture research investments globally to support healthy diets and good nutrition.** Global and national public research organizations (and their funders) must rebalance their priorities to reflect a priority focus on high-quality diets. **Much more investment in research on fruits and vegetables, animal source foods, legumes, nuts and seeds is urgently required.** Better national-level and subnational data are needed on diet, consumer food prices, food safety, food loss and waste. The Access to Nutrition Index that assesses the conduct and performance of companies should be strengthened at the country level.

Box 8.1 Research priorities

Research within the food system needs to be driven to a greater extent by the desire to achieve high-quality diets. For example, as the agenda-setting agricultural research system, the CGIAR needs to review how it allocates its annual US$1 billion research budget. Nutrition concerns should not only be signalled in one of its challenge programmes (Agriculture for Nutrition and Health), but in all of them. The CGIAR needs to review how it allocates funding in relation to the quality of the diets needed throughout the world. This may well affect its allocation by crop, by location and by stage in the food value chain. CGIAR needs to work with national agricultural research systems to support the development of mutual capacity to do this kind of work. Questions are also needed on what private sector research should be from a diet-quality perspective.

There is an urgent need for better data and metrics for diet quality and the food system. It is extraordinary that diet is the number one risk factor for the global burden of disease and yet the UN, to date, has no functioning global database on diet. Also, few national governments collect the data required to inform decision makers about what people actually eat. This report had to rely on a global database built by academics at Tufts University in the US, supported by the Bill & Melinda Gates Foundation. FAO and WHO should work closely with Tufts University to urgently populate the FAO/WHO GIFT (FAO/WHO Global Individual Food Consumption data Tool) database - and funders should be prepared to support them in doing so. Other efforts to gather data such as the Global Dietary Database (GDD) should also be built upon.

Other indicators also need to be collected to help policy makers make the links between food systems and high-quality diets. These include indicators related to consumer food price series, food safety, food loss and waste, as well as those that monitor implications for the environment. We also need scorecards to highlight those countries that have set targets for diet improvement and actions to improve diets (including policy, legislative and financial investments) and those countries who have implemented these commitments and to what effect.

The Access to Nutrition Index, which assesses the nutrition performance of large, multinational firms, needs to be strengthened and much more work needs to be implemented at the country level to assess the conduct and performance of companies in national markets. Companies that act to support high-quality diets should be congratulated and those that do not need to be encouraged to do better. *A Global State of Food Systems* report should be produced by an independent group of experts on an annual basis.

More and better evaluation is required. Policy makers need to be able to assess the effect that specific interventions and policy actions have on diet quality and to determine how they could be improved. For example, recent work to track changes in the purchases of sugar-sweetened beverages in Mexico following the imposition of a new tax sheds important light on consumer choices in a changing food environment.

This report highlights the very serious challenges facing policy makers today and in the future. Already, approximately three billion people on the planet – from every country – have low-quality diets.

But this report also shows that current trends do not have to persist if the right actions are taken now and in the coming decades. Better diets are possible. Ensuring that all people eat healthily is a moral and economic imperative. This will require focused, determined and sustained action from policy makers working in partnership with the private sector in complex and rapidly changing environments. With so much at stake, we all share a responsibility to find solutions that work for everyone. There are many public policy opportunities to act on in the food system beyond agriculture to improve the consumer's ability to access food that is safe, nutritious and affordable.

References

ACHARYA, T., FANZO, J., GUSTAFSON, D., INGRAM, J. & SCHNEEMAN, B. 2014. *Assessing Sustainable Nutrition Security: The Role of Food Systems*. Washington, DC: ILSI, CIMSANS.

ADVERTISINGAGE. 2013. Global Marketers 2013. Accessed 16 February 2016. http://adage.com/datacenter/globalmarketers2013#302.

AFFOGNON, H., MUTUNGI, C., SANGINGA, P. & BORGEMEISTER, C. 2015. Unpacking postharvest losses in sub-Saharan Africa: A meta-analysis. *World Development*, 66, 49-68.

ALEXANDRATOS, N. & BRUINSMA, J. 2012. World agriculture towards 2030/2050: The 2012 revision. ESA Working Paper No. 12-03. Rome, FAO.

ALSTON, J.M. & PARDEY, P.G. 2015. Agricultural R&D, Food Prices, Poverty and Malnutrition Redux. In: SAHAN D.E., ed. 2015. *The Fight Against Hunger and Malnutrition. The Role of Food, Agriculture and Targeted Policies*. Oxford: Oxford University Press. Chapter 9.

ANDERSON, K. 2010. Globalization's effects on world agricultural trade, 1960–2050. *Philosophical Transactions of the Royal Society of London B: Biological Sciences*, 365, 3007-21.

ASCHE, F., BELLEMARE, M.F., ROHEIM, C., SMITH, M.D. & TVETERAS, S. 2015. Fair enough? Food security and the international trade of seafood. World Development, 67, 151-160.

BABU, S.C. & BLOM, S. 2014. *Building resilience for food and nutrition security*. 2020 Conference Brief 6. Washington DC: IFPRI.

BAKER, P. 2016. Project future trends of processed food consumption. Working Paper No. 2. School of Regulation and Global Governance. Australian National University.

BAKER, P., KAY, A. & WALLS, H. 2014. Trade and investment liberalization and Asia's noncommunicable disease epidemic: A synthesis of data and existing literature. *Global Health*, 10, 66.

BAKER, P., SMITH, J., SALMON, L., FRIEL, S., KENT, G., IELLAMO, A., DADHICH, J.P. & RENFREW, M.J. 2016. Global trends and patterns of commercial milk-based formula sales: Is an unprecedented infant and young child feeding transition underway? *Public Health Nutrition*, 1-11

BAYO, A.O. 2006. City planning, city growth and food security: The inevitable trinity in the Nigerian food equation. *Agricultural Journal*, 1, 113-118.

BEREUTER D. & GLICKMAN, D. 2015. *Healthy Food for a Healthy World: Leveraging Agriculture and Food to Improve Global Nutrition*. Chicago, US: The Chicago Council on Global Affairs.

BEZERRA, I.N., DE MOURA SOUZA, A., PEREIRA, R.A. & SICHIERI, R. 2013. Contribution of foods consumed away from home to energy intake in Brazilian urban areas: The 2008–9 Nationwide Dietary Survey. *British Journal of Nutrition*, 109, 1276-83.

BHUTTA, Z.A., DAS, J.K., RIZVI, A., GAFFEY, M.F., WALKER, N., HORTON, S., WEBB, P., LARTEY, A. & BLACK, R.E. 2013. Evidence-based interventions for improvement of maternal and child nutrition: What can be done and at what cost? *The Lancet*, 382, 452-477.

BLACK, R.E., VICTORA, C.G., WALKER, S. P., BHUTTA, Z.A., CHRISTIAN, P., DE ONIS, M., EZZATI, M., GRANTHAM-MCGREGOR, S., KATZ, J., MARTORELL, R. & UAUY, R. 2013. Maternal and child undernutrition and overweight in low-income and middle-income countries. *The Lancet*, 382, 427-51.

BLACKMORE, E., ALONSO, S., & GRACE, D. 2015.Legitimising informal markets: a case study of the dairy sector in Kenya. IIED Briefing Papers. IIED.

BROWN-PAUL, C. 2014. Raising the roof [online]. *Practical Hydroponics and Greenhouses*. Casper Publications, 143, 38-41.

BRUNORI, G., GALLI, F., BARJOLLE, D., VAN BROEKHUIZEN, R., COLOMBO, L., GIAMPIETRO, M., KIRWAN, J., LANG, T., MATHIJS, E., MAYE, D., DE ROEST, K., ROUGOOR, C., SCHWARZ, J., SCHMITT, E., SMITH, J., STOJANOVIC, Z., TISENKOPFS, T. & TOUZARD, J.-M. 2016. Are local food chains more sustainable than global food chains? Considerations for assessment. *Sustainability*, 8, 449.

BUCHER, T., COLLINS, C., ROLLO, M.E., MCCAFFREY, T.A., DE VLIEGER, N., VAN DER BEND, D., TRUBY, H. & PEREZ-CUETO, F.J. 2016. Nudging consumers towards healthier choices: A systematic review of positional influences on food choice. *British Journal of Nutrition*, 115, 2252-63.

BURLINGAME, B. & DERNINI, S., eds. 2010. *Sustainable diets and biodiversity: Directions and solutions for policy, research and action*. Proceedings of the International Scientific Symposium on Biodiversity and Sustainable Diets United Against Hunger. Rome: FAO.

CAIRNS, G., ANGUS, K. & HASTINGS, G. 2009. The extent, nature and effects of food promotion to children: A review of the evidence to December 2008. Geneva: World Health Organization.

CANNING, D., RAJA, S. & YAZBECK, A.B. 2015. *Africa's Demographic Transition Dividend or Disaster*? Washington, DC: International Bank for Reconstruction and Development/World Bank.

CANNING, P. 2013. *ERS Food Dollar Series Allows an Indepth Look at Farm Level Components of the U.S. Food Dollar*. Accessed 15 March 2016, http://www.ers.usda.gov/amber-waves/2013-july/ers-food-dollar-series-allows-an-indepth-look-at-farm-level-components-of-the-us-food-dollar.aspx#.VuRatJOLRE6.

CAVALIERI, A. 2011. Former Vice-President and Director of Trait and Technology Development, Pioneer Hi-Bred International, 2009, personal communication.

CEBALLOS, F., HERNANDEZ, M.A., MINOT, N. & ROBLES, M. 2016. Transmission of Food Price Volatility from International to Domestic Markets: Evidence from Africa, Latin America and South Asia. In: KALKUHL, M., VON BRAUN J. & TORERO, M., eds. 2016. *Food Price Volatility and Its Implications for Food Security and Policy*. NY: Springer International Publishing. pp.303-328.

CHANDON, P. & WANSINK, B. 2012. Does food marketing need to make us fat? A review and solutions. *Nutrition Reviews*, 10, 571-593.

CHAVAS, J.P., HUMMELS, D. & WRIGHT, B.D. eds. 2014. *The economics of food price volatility*. Cambridge, Chicago, IL: National Bureau of Economic Research, University of Chicago Press.

COLCHERO, M.A., SALGADO, J.C., UNAR-MUNGUIA, M., HERNANDEZ-AVILA, M. & RIVERA-DOMMARCO, J.A. 2015. Price elasticity of the demand for sugar sweetened beverages and soft drinks in Mexico. *Economics & Human Biology*, 19, 129-37.

COMBS, G.F., WELCH, R.M., DUXBURY, J.M., UPHOFF, N.T. & NESHEIM, M.C. 1996. Food-based approaches to preventing micronutrient malnutrition: An international research agenda. Conference Paper. Cornell International.

CORNIA, G.A., DEOTTI, L. & SASSI, M. 2016. Sources of food price volatility and child malnutrition in Niger and Malawi. *Food Policy*, 30, 20-30.

CRITCHLEY, J., CAPEWELL, S., O'FLAHERTY, M., ABU-RMEILEH, N., RASTAM, S., SAIDI, O., SÖZMEN, K., SHOAIBI, A., HUSSEINI, A., FOUAD, F. & MANSOUR, N.B. 2016. Contrasting cardiovascular mortality trends in Eastern Mediterranean populations: Contributions from risk factor changes and treatments. *International Journal of Cardiology*, 208, 150-161

DARMON, N. & DREWNOWSKI, A. 2015. Contribution of food prices and diet cost to socioeconomic disparities in diet quality and health: A systematic review and analysis. *Nutrition Reviews*, 73, 643-660.

DAWAR, N. & FROST, T. 1999. Competing with giants: Survival strategies for local companies in emerging markets. *Harvard Business Review*, 77, 119-29.

DE BRAUW, A., EOZENOU, P. & MOURSI, M. 2015. Program participation Intensity and children's nutritional status: Evidence from a randomized control trial in Mozambique. HarvestPlus Working Paper. No 16. Harvest Plus.

DE SCHUTTER, O. 2010. *Addressing concentration in food supply chains. The role of competition law in tackling the abuse of buyer power*. Briefing Note 03. United Nations Special Rapporteur on the Right to Food.

DEL GOBBO, L.C., KHATIBZADEH, S., IMAMURA, F., MICHA, R., SHI, P., SMITH, M., MYERS, S.S. & MOZAFFARIAN, D. 2015. Assessing global dietary habits: A comparison of national estimates from FAO and the Global Dietary Database. *The American Journal of Clinical Nutrition*, 101, 1038-46.

DEL POZO-VERGNES, E. & VORLEY, B. 2015. Global or local food chains? Uncovering the dilemmas in Senegal and Peru. Issue paper, September 2015, International Institute for Development. London, UK: IIED.

DILLON, A., MCGEE, K. & OSENI, G. 2015. Agricultural production, dietary diversity and climate variability. *Journal of Development Studies*, 51, 976-995.

DIXON, J. 2015. IUHPE Position Paper: Advancing health promoting food systems. International Union for Health Promotion and Education. Paris: IUHPE

DOWNS, S.M. & FANZO, J. 2015. Is a cardio-protective diet sustainable? A review of the synergies and tensions between foods that promote the health of the heart and the planet. *Current Nutrition Reports*, 4, 313-322.

DOWNS, S.M., SINGH, A., GUPTA, V., LOCK, K. & GHOSH-JERATH, S. 2015. The need for multisectoral food chain approaches to reduce trans fat consumption in India. *BMC Public Health*, 15, 693.

DU, L. 2014. *Leveraging agriculture for nutritional impact through the Feed the Future Initiative*: *Landscape analysis of activities across 19 focus countries.* Arlington, VA: United States Agency for International Development (USAID)/Strengthening Partnerships, Results and Innovations in Nutrition Globally Project.

DURIAUX J.Y. & BAUDRON F. 2015. *Landscape mosaics and rural livelihoods along an intensification gradient in Arsi-Negele, Ethiopia. The new agrarian change.* Technical Project Report, September 2015.

EAMES-SHEAVLY, M., HADEKEL, C., HEDSTROM, A. M., PATCHEN, A., STEWART, R. & WILKINS, J. 2011. *Discovering our food system: Experiential learning and action for youth and their communities*. Cornell University, Department of Horticulture.

ELLIOT, V., LUTTER, C., LAMSTEIN, S., KONIZ-BOOHER, P. & CAULFIELD L. 2015. Systematic review of the dietary intakes of adolescent girls in low-and middle-Income countries. *The FASEB Journal*, 29.

ERICKSEN, P.J. 2008. Conceptualizing food systems for global environmental change research. *Global Environmental Change*, 18, 234-245.

ETH (Swiss Federal Institute of Technology Zurich). 2016. 2016 KOF Index of Globalization. Accessed 7 May 2016 http://globalization.kof.ethz.ch/media/filer_public/2016/03/03/method_2016.pdf.

EVENSON, R.E. & GOLLIN, D. 2003. Assessing the impact of the green revolution, 1960 to 2000. Science, 300, 758-62.

FANZO, J., COGILL, B. & MATTEI, F. 2012. *Metrics of Sustainable Diets and Food Systems*. Rome: Bioversity International.

FAO (FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS) & FHI 360. 2014. *Introducing the minimum dietary diversity – women (MDD-W) global dietary diversity indicator for women*. Rome: FAO.

FAO & ITPS (Intergovernmental Technical Panel on Soils). 2015. *Status of the world's soil resources (SWSR)* – Main Report. Rome, Italy: (ITPS) FAO.

FAO & WHO (WORLD HEALTH ORGANIZATION). 2001. *Human vitamin and mineral requirements*. Report of a joint FAO/WHO expert consultation – Bangkok, Thailand. Rome: FAO.

FAO & WHO. 2007. *FAO/WHO Framework for the provision of scientific advice on food safety and nutrition*. Rome: FAO/WHO.

FAO & EU (European Union). 2010. *Guidelines for measuring household and individual dietary diversity*. Rome: FAO.

FAO, IFAD (INTERNATIONAL FUND FOR AGRICULTURAL DEVELOPMENT) & WFP (WORLD FOOD PROGRAMME). 2015a. *Achieving zero hunger: The critical role of investments in social protection and agricultur*e. Rome. FAO.

FAO, IFAD & WFP. 2015b. *The state of food insecurity in the world 2015. Meeting the 2015 international hunger targets: Taking stock of uneven progress*. Rome: FAO.

FAO, WHO & UNU (UNITED NATIONS UNIVERSITY). 2001. *Human energy requirements*. Report of a joint FAO/WHO/UNU Expert Consultation. Rome: FAO.

FAO. 2004. *Globalization of food systems in developing countries: A synthesis of country case studies*. Chapter 1: KENNEDY, G., NANTEL, G. AND SHETTY, P. Rome: FAO.

FAO. 2010. The Impact of global change and urbanization on household food security. *Nutrition & Food Safety*. Accessed 20 April 2016 http://www.fao.org/ag/agn/nutrition/national_urbanization_en.stm.

FAO. 2011. *Global food losses and food waste: Extent, causes and prevention*. Rome: FAO.

FAO. 2013. *The state of food and agriculture 2013: Food systems for better nutrition*. Rome: FAO.

FAO. 2015a. *FAOSTAT – Food balance sheets*. Accessed 15 February 2016, http://faostat3.fao.org/download/FB/*/E.

FAO. 2015b. The state of agricultural commodity markets – Trade and food security: Achieving a better balance between national priorities and the collective good. Rome: FAO.

FAO. 2016a. Fruit and vegetable products. Corporate Document Repository. Accessed 21 May 2016, http://www.fao.org/wairdocs/x5434e/x5434e05.htm#TopOfPage.

FAO. 2016b. *Food-based dietary guidelines*. Accessed 1 February 2016 http://www.fao.org/nutrition/nutrition-education/food-dietary-guidelines/en/.

FAO. 2016c. *ICN2 Second International Conference on Nutrition: Better Nutrition, Better Lives*. Accessed 20 May 2016, http://www.fao.org/about/meetings/icn2/news/news-detail/en/c/264683/.

FAO. 2016d. UN General Assembly proclaims Decade of Action on Nutrition. Accessed 21 May 2016, http://www.fao.org/news/story/en/item/408970/icode/.

FAO. 2016e. *Urban agriculture*. Accessed 6 May 2016, http://www.fao.org/urban-agriculture/en/.

FOOD ENGINEERING. 2016. The World's Top 100 Food and Beverage Companies. Accessed 11 February 2016 http://www.foodengineeringmag.com/search?q=The+World%E2%80%99s+Top+100+-Food+and+BBeverag+Companies.

FRIEL, S., LABONTE, R. & SANDERS, D. 2013. Measuring progress on diet-related NCDs: The need to address the causes of the causes. *The Lancet*, 381, 903-4.

FUGLIE, K. & RADA, N. 2013. Growth in Global Agricultural Productivity: An Update. Accessed 25 April 2016, http://www.ers.usda.gov/amber-waves/2013-november/growth-in-global-agricultural-productivity-an-update.aspx#.VuReXZOLRE4.

FUGLIE, K., HEISEY, P., KING, J.L., PRAY, C.E., DAY-RUBENSTEIN, K., SCHIMMELPFENNIG, D., WANG, S.L. & KARMARKAR-DESHMUKH, R. 2011. *Research investments and market structure in the food processing, agriculture input and biofuel industries worldwid*e. Report No130. Washington, DC: Economic Research Services, United States Department of Agriculture.

GARNETT, T. 2014. What is a sustainable healthy diet? FCRN Discussion Paper. FCRN: University of Oxford. Accessed 25 February 2016 http://www.fcrn.org.uk/sites/default/files/fcrn_what_is_a_sustainable_healthy_diet_final.pdf.

GARNETT, T. 2016. *Future trends in the production, transformation, food environment and consumption for animal-based foods*. Working Paper No 6. Environment Change Institute. Oxford University Centre for the Environment.

GIRARD, A.W., SELF, J.L., MCAULIFFE, C. & OLUDE, O. 2012. The effects of household food production strategies on the health and nutrition outcomes of women and young children: A systematic review. *Paediatric and Perinatal Epidemiology*, 26, 205-22.

GLADEK, E., FRASER, M., ROEMERS, G., MUS, G., MUMIOLOGY, C. & OLUDE, O. 2016. *The Global Food System*: An Analysis. Amsterdam, The Netherlands: Metabolic/WWF Netherlands.

GLANZ, K., SALLIS, J.F., SAELENS, B.E. & FRANK, L.D. 2005. Healthy nutrition environments: Concepts and measures. *American Journal of Health Promotion*, 19, 330-3.

GLIESSMAN, S.R. 2007. Agroecology: *The Ecology of Sustainable Food Systems*. 2nd edn. UK: CRC Press, Taylor and Francis Group.

GLOBAL BURDEN OF DISEASE STUDY 2013. COLLABORATORS: FOROUZANFAR, M.H., ALEXANDER, L., ANDERSON, H.R., BACHMAN, V.F., BIRYUKOV, S., BRAUER, M., BURNETT, R., CASEY, D., COATES, M.M., COHEN, A., et al. 2015. Global, regional and national comparative risk assessment of 79 behavioural, environmental and occupational and metabolic risks or clusters of risks in 188 countries, 1990–2013: A systematic analysis for the Global Burden of Disease Study 2013. *The Lancet*, 386, 2287-323, doi: 10.1016/S0140–6736(15)00128-2.

GLOBAL NUTRITION AND POLICY CONSORTIUM. 2014. *The Global Dietary Database: Measuring diet in countries worldwide*. Accessed 20 February 2016 http://www.globaldietarydatabase.org/the-global-dietary-database-measuring-diet-worldwide.html.

GLOBAL PANEL ON AGRICULTURE AND FOOD SYSTEMS FOR NUTRITION (GLOBAL PANEL). 2014. *How can agriculture and food system policies improve nutrition?* Technical Brief, London, UK: Global Panel on Agriculture and Food Systems for Nutrition.

GLOBAL PANEL. 2015a. *Climate smart food systems for enhanced nutrition*. Policy Brief. London, UK: Global Panel on Agriculture and Food Systems for Nutrition.

GLOBAL PANEL. 2015b. Biofortification: *An agricultural investment for nutrition*. Policy Brief. London, UK: Global Panel on Agriculture and Food Systems for Nutrition.

GLOBAL PANEL. 2015c. *Healthy meals in schools: Policy innovations linking agriculture, food systems and nutrition*. Policy Brief. London, UK: Global Panel on Agriculture and Food Systems for Nutrition.

GLOBAL PANEL. 2015d. *Improved metrics and data are needed for effective food system policies in the post-2015 era*. Technical Brief. London, UK: Global Panel on Agriculture and Food Systems for Nutrition.

GLOBAL PANEL. 2016a. *Managing food price volatility: Policy options to support healthy diets and nutrition in the context of uncertainty*. Policy Brief. London, UK: Global Panel on Agriculture and Food Systems for Nutrition.

GLOBAL PANEL. 2016b. *Assuring safe food systems: Policy options for a healthier food supply*. Policy Brief. London, UK: Global Panel on Agriculture and Food Systems for Nutrition.

GLOBAL PANEL. 2016c. *Nutrition for Growth II, from Commitment to Action. Recommendations to Improve Nutrition through Agriculture and Food Systems.* Policy Brief No.6. London, UK: Global Panel on Agriculture and Food Systems for Nutrition.

GODFRAY, H.C. & GARNETT, T. 2014. Food security and sustainable intensification. *Philosophical Transactions of the Royal Society of London B: Biological Sciences*, 369, 20120273.

GÓMEZ, M.I. & RICKETTS, K.D. 2013. *Food value chain transformations in developing countries: Selected hypotheses on nutritional implications*. ESA Working Paper No. 13-05. Rome: FAO.

GONZALEZ FISCHER, C. & GARNETT, T. 2016. *Plates, pyramids, planet developments in national healthy and sustainable dietary guidelines: A state of play assessment*. FAO and the University of Oxford.

GORYAKIN, Y., LOBSTEIN, T., JAMES, W.P. & SUHRCKE, M. 2015. The impact of economic, political and social globalization on overweight and obesity in the 56 low- and middle-income countries. *Social Science and Medicine*, 133, 67-76.

GRACE, D. 2015. Food safety in low- and middle-income countries. *International Journal of Environmental Research and Public Health*, 12, 10490-507.

GREEN, R., CORNELSEN, L., DANGOUR, A.D., TURNER, R., SHANKAR, B., MAZZOCCHI, M. & SMITH, R. D. 2013. The effect of rising food prices on food consumption: Systematic review with meta-regression. *British Medical Journal*, 346, f3703, doi: http://doi.org/10.1136/bmj.f3703.

HADDAD, L., BROWN, L.R., RICHTER, A. & SMITH, L. 1995. The gender dimensions of economic adjustment policies: potential interactions and evidence to date. *World Development*, 30, 881-96.

HADDAD, L., NISBETT, N., BARNETT, I. & VALLI, E. 2014. *Maharashtra's Child Stunting Declines: What Is Driving Them? Findings of a Multidisciplinary Analysis*. Brighton: Institute of Development Studies.

HASTINGS, G., STEAD, M., MCDERMOTT, L., FORSYTH, A., MACKINTOSH, A.M., RAYNER, M., GODFREY, C., CARAHER, M. & ANGUS K. 2003. *Review of research on the effects of food promotion to children*. Glasgow: University of Strathclyde, Centre for Social Marketing.

HASTINGS, G., MCDERMOTT, L., ANGUS K., STEAD, M. & THOMPSON, S. 2006. *The extent, nature and effects of food promotion to children: A review of the evidence. Technical Paper prepared for the World Health Organization*. Geneva: World Health Organization.

HATANAKA, M., BAIN, C. & BUSCH, L. 2006. Differentiated standardization, standardized differentiation: The complexity of the global agrifood system. *Research in Rural Sociology and Development*, 12, 39–68.

HAWKES, C. 2002. Marketing activities of global soft drink and fast food companies in emerging markets: A Review. In: WHO. 2002. Globalization, *Diets and Noncommunicable Diseases*. Geneva: WHO.

HAWKES, C. 2010. The influence of trade liberalization and global dietary change: The case of vegetable oils, meat and highly processed foods. In: HAWKES C., BLOUIN C., HENSON S., DRAGER N. & DUBÉ L., eds. 2010. *Trade, Food, Diet and Health: Perspectives and Policy Options*. Wiley-Blackwell; Hoboken, NJ. pp. 35–59.

HAWKES, C. 2014. Promotional marketing. A driver of the modern food system. In: NEEF, R. 2014. *Introduction to the US Food System: Public Health, Environment and Equity*. The Johns Hopkins Center for a Livable Future. Jossey-Bass A Wiley Brand; San Francisco: CA: 2014. pp. 237-261.

HAWKES, C. 2015. *Enhancing coherence between trade policy and nutrition action implementing the Framework for Action of the Second International Conference on Nutrition*. Geneva: United Nations Standing Committee on Nutrition.

HAWKES, C., BLOUIN C., HENSON, S., DRAGER, N. & DUBÉ, L. 2009. *Trade, Food, Diet and Health: Perspectives and Policy Options*. Oxford, U.K. John Wiley and Sons.

HAWKES, C., FRIEL, S., LOBSTEIN, T., & LANG, T. 2012. . Linking agricultural policies with obesity and non-communicable diseases: a new perspective for a globalizing world. *Food Policy*, 37, 343-353

HAWKES, C., GRACE, D. & THOW, A.M. 2015. Trade liberalization, food, nutrition and health. In: SMITH, R., BLOUIN, C., MIRZA, Z., BEYER, P. & DRAGER, N. *Trade and Health: Towards a National Strategy*, p.92. Geneva, WHO.

HAWKES, C., SMITH, T.G., JEWELL, J., WARDLE, J., HAMMOND, R.A., FRIEL, S., THOW, A.M. & KAIN, J. 2015. Smart food policies for obesity prevention. *The Lancet*, 385, 2410-2421.

HEADEY, D.D. & HODDINOTT, J. 2014. Understanding the rapid reduction of undernutrition in Nepal, 2001–2011. *PLOS ONE*, 23, doi:10.1371/journal.pone.0145738.

HEADEY, D., HODDINOTT, J., ALI, D., TESFAYE, R. & DEREJE, M. 2015. The other Asian enigma: Explaining the rapid reduction of undernutrition in Bangladesh. *World Development*, 66, 749-761, doi:10.1016/j.worlddev.2014.09.022.

HENDRY, V.L., ALMÍRON-ROIG, E., MONSIVAIS, P., JEBB, S.A., BENJAMIN NEELON, S.E., GRIFFIN, S.J. & OGILVIE, D.B. 2015. Impact of regulatory interventions to reduce intake of artificial trans-fatty acids: A systematic review. *American Journal of Public Health*, 105, e32-42.

HERFORTH, A. & AHMED, S. 2015. The food environment, its effects on dietary consumption and potential for measurement within agriculture-nutrition interventions. *Food Security*, 7, 505-20.

HLPE (High Level Panel of Experts on Food Security and Nutrition). 2014. *Food losses and waste in the context of sustainable food systems*. A report by the High Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security. Rome: HLPE.

HODDINOTT, J., HEADEY, D. & DEREJE, M. 2015. Cows, missing milk markets and nutrition in rural Ethiopia. *Journal of Development Studies*, 51, 958-975.

HODDINOTT, J., MALUCCIO, J.A., BEHRMAN, J.R., FLORES, R. & MARTORELL, R. 2008. Effect of a nutrition intervention during early childhood on economic productivity in Guatemalan adults. *The Lancet*, 371, 411-6.

HORTON, S. & STECKEL, R.H. 2013. Malnutrition. Global economic losses attributable to malnutrition 1900–2000 and projections to 2050. In: LOMBORG, B., ed. 2013. *How Much Have Global Problems Cost the World? A Scorecard from 1900 to 2050*. Cambridge: Cambridge University Press. pp. 247-272.

HOSSAIN, N., KING, R., WANJIKU KELBERT, A., SCOTT-VILLIERS, P. & CHISHOLM, N. 2015. *Delicious, disgusting, dangerous: Eating in a time of food price volatility*. Institute of Development Studies and Oxfam International.

HUANG, S. 2010. Global trade of fruits and vegetables and the role of consumer demand. In: HAWKES, C., BLOUIN, C., HENSON S., DRAGER N. & DUBÉ L., eds. *Trade, Food, Diet and Health: Perspectives and Policy Options*. Wiley-Blackwell; Hoboken, NJ: 2010. pp. 60-76.

IFPRI (International Food Policy Research Institute). 2014. *Global nutrition report 2014: Actions and accountability to accelerate the world's progress on nutrition*. Washington, DC: IFPRI.

IFPRI. 2015a. Global nutrition report 2015: *Actions and accountability to advance nutrition and sustainable development*. Washington, DC: IFPRI.

IFPRI. 2015b. *Global nutrition report: Nutrition country profile 2014: Colombia.* Washington, DC: IFPRI. Accessed 26 May 2016 http://ebrary.ifpri.org/utils/getfile/collection/p15738coll2/id/129911/filename/130122.pdf.

IFPRI. 2015c. *Global nutrition report: Nutrition country profile: United Republic of Tanzania*. Washington, DC: IFPRI. Accessed 26 May 2016 http://ebrary.ifpri.org/utils/getfile/collection/p15738coll2/id/129845/filename/130056.pdf.

IFPRI. 2016a. *Global nutrition report 2016: From promise to impact: Ending malnutrition by 2030*. Washington, DC: IFPRI.

IFPRI. 2016b. *2016 Global food policy report*. Washington, DC: IFPRI.

IMAMURA, F., MICHA, R., KHATIBZADEH, S., FAHIMI, S., SHI, P., POWLES, J. & MOZAFFARIAN, D. 2015. Dietary quality among men and women in 187 countries in 1990 and 2010: A systematic assessment. *Lancet Global Health*, 3, e132–42.

IOM (INSTITUTE OF MEDICINE) and NRC (NATIONAL RESEARCH COUNCIL). 2015. *A Framework for Assessing Effects of The Food System*. Washington, DC: The National Academies Press.

IPES-FOOD (INTERNATIONAL PANEL OF EXPERTS ON SUSTAINABLE FOOD SYSTEMS). 2015. *The new science of sustainable food systems: Overcoming barriers to food systems reform*. IPES-food.

JONES, A.D., SHRINIVAS, A. & BEZNER-KERR, R. 2014. Farm production diversity is associated with greater household dietary diversity in Malawi: Findings from nationally representative data. *Food Policy*, 46, 1–12.

KELLY, T., YANG, W., CHEN, C.S., REYNOLDS, K. & HE, J. 2008. Global burden of obesity in 2005 and projections to 2030. *International Journal of Obesity (Lond)*, 32, 1431-7.

KHOURY, C.K. & JARVIS, A. 2014. *The changing composition of the global diet: Implications for CGIAR* research. CIAT Policy Brief No. 18. Accessed 25 February 2016, https://ciat.cgiar.org/wp-content/uploads/2014/11/policy_brief_global_diets.pdf.

KITINOJA, L. 2013. *Returnable plastic crate (RPC) systems can reduce postharvest losses and improve earnings for fresh produce operations*. PEF White Paper No. 13-01. Oregon, USA: Postharvest Education Foundation.

KOTHARI, M.T., ABDERRAHIM, N., COILE, A. & CHENG, Y. 2014. *Nutritional Status of Women and Children*. Rockville, Maryland, USA: ICF International.

KUMAR, N., HARRIS, J. & RAWAT, R. 2015. If they grow it, will they eat and grow? Evidence from Zambia on agricultural diversity and child undernutrition. *Journal of Development Studies*, 51, 1060-77.

LACHAT, C., NAGO, E., VERSTRAETEN, R., ROBERFROID, D., VAN CAMP, J. & KOLSTEREN, P. 2012. Eating out of home and its association with dietary intake: A systematic review of the evidence. *Obesity Reviews*, 13, 329-46.

LAKNER, C., NEGRE, M. & PRYDZ, E.B. 2014. *Twinning the goals: How can promoting shared prosperity help to reduce global poverty?* World Bank Policy Research Working Paper 7106. Development Research Group Poverty and Inequality Team.

LEROY, J.L., RUEL, M., FRONGILLO, E.A., HARRIS, J. & BALLARD, T.J. 2015. Measuring the food access dimension of food security: A critical review and mapping of indicators. *Food and Nutrition Bulletin*, 36, 167-95.

LIPINSKI, B., HANSON, C., LOMAX, J., KITINOJA, L., WAITE, R. & SEARCHINGER, T. 2013. *Reducing food loss and waste*. Working Paper, Instalment 2 of Creating a Sustainable Food Future. Washington, DC: World Resources Institute.

LIU, X. & ZHU, C. 2014. Will knowing diabetes affect labor income? Evidence from a natural experiment. *Economic Letters*, 124, 74-78.

LUO, H., ZHU, M., YE, S., HOU, H., CHEN Y, & BULYSHEVA, L. 2016. An intelligent tracking system based on internet of things for the cold chain. *Internet Research*, 26, 435-45.

MALIK, V.S., WILLETT, W.C. & HU, F.B. 2013. Global obesity: Trends, risk factors and policy implications. *Nature Reviews Endocrinology*, 9, 13-27.

MASSET, E., HADDAD, L., CORNELIUS, A. & ISAZA-CASTRO, J. 2012. Effectiveness of agricultural interventions that aim to improve nutritional status of children: Systematic review. *British Medical Journal* 344:d8222.

MASTERS, W. 2016. *Assessment of current diets: Recent trends by income and region*. Working paper No 4. Friedman School of Nutrition Science and Policy and Department of Economics. Tufts University.

MATUSCHKE, I. 2009. Rapid urbanization and food security: Using food density maps to identify future food security hotspots. International Association of Agricultural Economist Conference. Beijing, China: FAO.

MAYÉN, A.L., MARQUES-VIDAL, P., PACCAUD, F., BOVET, P. & STRINGHINI, S. 2014. Socioeconomic determinants of dietary patterns in low- and middle-income countries: A systematic review. *The American Journal of Clinical Nutrition*, 100, 1520-31.

MAZUR, R., HENDRICH, S., JENSEN, H., MURPHY, P., REDDY, M., WESTGATE, M., NAKIMBUGWE, D., UGEN, M., MUSOKE, H.K., VASANTHAKAALAM, H., NAKIMULI, A., ELEPU, G. & KIIZA, B. 2012. Enhancing Nutritional Value and Marketability of Beans through Research and Strengthening Key Value Chain Stakeholders in Uganda and Rwanda. 2020 Conference Note 1. Washington, D.C. International Food Policy Research Institute (IFPRI).

MCCAULEY, D.J., PINSKY, M.L., PALUMBI, S.R., ESTES, J.A., JOYCE, F.H. & WARNER, R.R. 2015. Marine defaunation: Animal loss in the global ocean. *Science,* 347, 1255641.

MCGINNIS, J.M., GOOTMAN, J.A. & KRAAK, V.I. eds. 2006. *Food marketing to children and youth: Threat or opportunity?* Washington D.C. Institute of Medicine of The National Academies.

MEADE, B., THORNSBURY, S., CALVIN, L. & MUHAMMAD, A. 2016. *Future trends in vegetables and fruit: Production, trade, consumption and policy options*. Working Paper No 7. Economic Research Service/USDA.

MEHROTRA, S. 2015. *Realising the Demographic Dividend Policies to Achieve Inclusive Growth in India*. Cambridge: Cambridge University Press.

MICHA, R., KHATIBZADEH, S., SHI, P., FAHIMI, S., LIM, S., ANDREWS, K.G., ENGELL, R.E., POWLES, J., EZZATI, M. & MOZAFFARIAN, D. 2014. Global, regional and national consumption levels of dietary fats and oils in 1990 and 2010: A systematic analysis including 266 country-specific nutrition surveys. *British Medical Journal*, 348, g2272, doi: 10.1136/bmjopen-2015-008705.

MILJKOVIC, D., SHAIK, S., MIRANDA, S., BARABANOV, N. & LIOGIER, A. 2015. Globalisation and Obesity. *The World Economy*, 38, 1278-94, doi: 10.1111/twec.12260.

MILLER, D. 2016. Agriculture and micronutrient availability. In: PRITCHARD, B., ORTIZ, R. & SHEKAR, M., eds. 2016. *Routledge Handbook of Food and Nutrition Security*. New York: Routledge. pp. 75-95.

MILNER, J., GREEN, R., DANGOUR, A.D., HAINES, A., CHALABI, Z., SPADARO, J., MARKANDYA, A. & WILKINSON, P. 2015. Health effects of adopting low greenhouse gas emission diets in the UK. *British Medical Journal Open*, 5, e007364.

MINOT, N. 2014. Food price volatility in sub-Saharan Africa: Has it really increased?. *Food Policy*, 30, 45-56.

MONDELĒZ INTERNATIONAL. 2016a. Unleashing a Global Snacking Powerhouse. 2016 Fact Sheet. Accessed 21 June 2016. http://www.mondelezinternational.com/~/media/MondelezCorporate/Uploads/downloads/mondelez_intl_fact_sheet.pdf.

MONDELĒZ INTERNATIONAL. 2016b. Investing in BRIC Markets. 2016 Fact Sheet. Accessed 21 June 2016. http://www.mondelezinternational.com/~/media/mondelezcorporate/uploads/downloads/ininvesti_in_bric_markets.pdf.

MONTEIRO, C.A., BENICIO, M.H.D.A., KONNO, S.C., SILVA, A.C.F.D., LIMA, A.L.L.D. & CONDE, W.L. 2009. Causes for the decline in child under-nutrition in Brazil, 1996–2007. *Revista de Saude Publica*, 43, 35-43.

MURRELL, D. 2016. *Global Research and Funding Survey on Pulse Productivity and Sustainability*. Dubai, UAE: Global Pulse Confederation.

MYERS, S.S., WESSELLS, K.R., KLOOG, I., ZANOBETTI, A. & SCHWARTZ, J. 2015. Effect of increased concentrations of atmospheric carbon dioxide on the global threat of zinc deficiency: A modelling study. *Lancet Global Health*, 3, e639-45.

NATAWIDJAJA, R., REARDON, T. & SHETTY, S. 2007. *Horticultural Producers and Supermarket Development in Indonesia*. Jakarta, Indonesia: World Bank.

NCD RISK FACTOR COLLABORATION (NCD-RisC). 2016. Trends in adult body-mass index in 200 countries from 1975 to 2014: A pooled analysis of 1698 population-based measurement studies with 19.2 million participants. *The Lancet*, 387, 1377-96.

NEFF, R.A., MERRIGAN, K. & WALLINGA, D. 2015. A food systems approach to healthy food and agriculture policy. *Health Affairs*, 34, 1908-15.

NELSON, G.C., VALIN, H., SANDS, R.D., HAVLIK, P., AHAMMAD, H., DERYNG, D., ELLIOTT, J., FUJIMORI, S., HASEGAWA, T., HEYHOE, E., et al. 2014. Climate change effects on agriculture: Economic responses to biophysical shocks. *Proceedings of the National Academy of Science of the United States of America*, 111, 3274-9.

NEVEN, D., REARDON, T., CHEGE, J. & WANG, H. 2006. Supermarkets and consumers in Africa: The case of Nairobi, Kenya. *Journal of International Food and Agribusiness Marketing*, 18, doi:10.1300/J047v18n01_06.

NORRIS, S.A., WROTTESLEY, S., MOHAMED, R.S. & MICKLESFIELD, L.K. 2014. Africa in transition: growth trends in children and implications for nutrition. *Annals of Nutrition and Metabolism*, 22, 8-13.

O'DONNELL, O., NICOLÁS, A.L. & DOORSLAER, E.V. 2009. Growing richer and taller: Explaining change in the distribution of child nutritional status during Vietnam's economic boom. *Journal of Development Economics*, 88, 45-58.

OLNEY, D.K., PEDEHOMBGA, A., RUEL, M.T. & DILLON, A. 2015. A 2-year integrated agriculture and nutrition and health behavior change communication program targeted to women in Burkina Faso reduces anemia, wasting and diarrhea in children 3–12 months of age at baseline: A cluster-randomized controlled trial. *Journal of Nutrition*, 145, 1317-1324.

O'NEILL, B.C., KRIEGLER, E., RIAHI, K., EBI, K.L., HALLEGATTE, S., CARTER, T.R., MATHUR, R. & VAN VUUREN D.P. 2014. A new scenario framework for climate change research: The concept of shared socioeconomic pathways. *Climatic Change*, 122, 387–400.

PAHO (PAN AMERICAN HEALTH ORGANIZATION). 2015. *Ultra-processed food and drink products in Latin America: Trends, impact on obesity, policy implications*. Washington, DC: PAHO.

PARDEY, P.G., ALSTON, J.M. & PIGGOTT, R.R. 2006. *Agricultural R&D in the developing world: Too little, too late?* Washington, DC: IFPRI.

PINGALI, P.L. 2012. Green revolution: Impacts, limits and the path ahead. *Proceedings of the National Academy of Science of the United States of America*, 109, 12302-12308.

PINSTRUP-ANDERSEN, P., ed. 2015. *Food Price Policy in an Era of Market Instability: A Political Economy Analysis*. Oxford: Oxford University Press.

POPKIN, B.M. & SLINING, M. 2013. New dynamics in global obesity facing low- and middle-income countries. *Obesity Reviews*, 14, 11-20, doi:10.1111/obr.12102.

RAO, M., AFSHIN, A., SINGH, G. & MOZAFFARIAN, D. 2013. Do healthier foods and diet patterns cost more than less healthy options? A systematic review and meta-analysis. *British Medical Journal Open*, 3, e004277.

REARDON, T. 2004. *The Rise of Supermarkets in Mexico*. LAC Bureau Poverty Reduction. Washington, DC: Chemonics International Inc.

REARDON, T. 2015. The hidden middle: The quiet revolution in the midstream of agrifood value chains in developing countries. *Oxford Review of Economic Policy*, 31, 45-63.

REARDON, T.A. 2016. *Growing Food for Growing Cities: Transforming Food Systems in an Urbanizing World*. Chicago, US: The Chicago Council on Global Affairs.

REARDON, T. & TIMMER, C.P. 2012. The economics of the food system revolution. *Annual Review of Resource Economics*, 2012, 225-264.

REARDON, T. & TIMMER, C.P. 2014. Five inter-linked transformations in the Asian agrifood economy: Food security implications. Global Food Security, 3, 108-117.

REARDON, T., TIMMER, C.P., BARRETT, C.B. & BERDEGUE, J. 2003. The rise of supermarkets in Africa, Asia and Latin America. *American Journal of Agricultural Economics*, 85, 1140-1146.

REMANS, R., WOOD, S.A., SAHA, N., ANDERMAN, T.L. & DEFRIES, R.S. 2014. Measuring nutritional diversity of national food supplies. *Global Food Security*, 3, 174-182, http://dx.doi.org/10.1016/j.gfs.2014.07.001.

ROBERTO, C.A., SWINBURN, B., HAWKES, C., HUANG, T.T., COSTA, S.A., ASHE, M., ZWICKER, L., CAWLEY, J.H. & BROWNELL, K.D. 2015. Patchy progress on obesity prevention: Emerging examples, entrenched barriers and new thinking. *The Lancet*, 385, 2400-2409.

ROBINSON, S.,MASON-D'CROZ D., ISLAM S, SULSER T.B., ROBERTSON R., ZHU T., GUENEAU A., PITOIS G. & ROSEGRANT, M. 2015. *The international model for policy analysis of agricultural commodities and trade (IMPACT); Model description for version 3*. IFPRI Discussion Paper. International Food Policy Research Institute: Washington, DC: IFPRI.

ROCHA, C. & LESSA, I. 2009. Urban governance for food security: The alternative food system in Belo Horizonte, Brazil. *International Planning Studies*, 14, 389-400.

ROESEL, K. & GRACE, D. eds. 2015. *Food Safety and Informal Markets: Animal Products in Sub-Saharan Africa*. London, UK: Routledge.

RUEL, M.T. & ALDERMAN, H. 2013. Nutrition-sensitive interventions and programmes: How can they help to accelerate progress in improving maternal and child nutrition? *The Lancet*, 382, 536-551.

RUIZ-GARCIA, L., LUNADEI, L., BARREIRO, P. & ROBLA, J.I. 2009. A review of wireless sensor technologies and applications in agriculture and food industry: State of the art and current trends. *Sensors*, 9, 4728-50.

SAMADI, S. 2014. Applications and Opportunities for Internet-based Technologies in the Food Industry. In the Sixth International Conference on Advances in Future Internet, AFIN, Lisbon, Portugal, 67-71.

SCHWINGSHACKL, L. & HOFFMANN, G. 2015. Diet quality as assessed by the healthy eating index, the alternate healthy eating index, the dietary approaches to stop hypertension score and health outcomes: A systematic review and meta-analysis of cohort studies. *Journal of the Academy of Nutrition and Dietetics*, 115, 780-800 e5.

SETO, K.C. & RAMANKUTTY, N. 2016. Hidden linkages between urbanization and food systems. *Science*, 352, 943-5.

SIBHATU, K.T., KRISHNA, V.V & QAIM, M. 2015. Production diversity and dietary diversity in smallholder farm households. *Proceedings of the National Academy of Sciences*, 112, 10657-10662.

SIEGEL, K.R., ALI, M.K., SRINIVASIAH, A., NUGENT, R.A. & NARAYAN, K.V. 2014. Do we produce enough fruits and vegetables to meet global health need? *PLOS ONE*, 9, e104059.

SKOUFIAS, E., TIWARI, S. & ZAMAN, H. 2011. *Can we rely on cash transfers to protect dietary diversity during food crises?* Estimates from Indonesia. Policy Research Working Paper No. WPS 5548. Washington, DC: World Bank.

SMITH, M.R., SINGH, G.M., MOZAFFARIAN, D. & MYERS, S.S. 2015. Effects of decreases of animal pollinators on human nutrition and global health: A modelling analysis. *The Lancet*, 386, 1964-72.

SOBAL, J., KHAN, L.K. & BISOGNI, C. 1998. A conceptual model of the food and nutrition system. *Social Science and Medicine*, 47, 853-863.

SOLABILITY SUTAINABLE INTELIGENCE. 2016. Natural capital. The given physical environment: Natural capital. Accessed 10 July 2016, http://solability.com/the-global-sustainable-competitiveness-index/the-index/natural-capital.

SPRINGMANN, M., GODFRAY, H. C. J., RAYNER, M., SCARBOROUGH, P. 2016a. Analysis and valuation of the health and climate change cobenefits of dietary change, *Proceedings of the National Academy of Sciences of the United States*, 113 (15), 4146–4151.

SPRINGMANN, M., GODFRAY, H.C., RAYNER, M. & SCARBOROUGH, P. 2016b. Analysis and valuation of the health and climate change cobenefits of dietary change. *Proceedings of the National Academy of Sciences of the United States of America*, 113, 4146-4151. doi:10.1073/pnas.1523119113.

SPRINGMANN, M., MASON-D'CROZ, D., ROBINSON, S., WIEBE, K., SCARBOROUGH, P. 2016c. *Projections of food consumption and the health impacts associated with changes in dietary and weight-related risk factors.* Working Paper No 1. University of Oxford. https://oxris.ox.ac.uk/repository.html?pub=664306.

STATISTA. 2016. Largest global advertisers in 2013, by ad spending (in billion U.S. dollars). Accessed 16 February 2016, http://www.statista.com/statistics/286448/largest-global-advertisers/.

STEYN, N.P., MCHIZA, Z., HILL, J., DAVIDS, Y.D., VENTER, I., HINRICHSEN, E., OPPERMAN, M., RUMBELOW, J. & JACOBS, P. 2014. Nutritional contribution of street foods to the diet of people in developing countries: A systematic review. *Public Health Nutrition*, 1, 1363-74.

STORY, M., KAPHINGST, K.M., ROBINSON-O'BRIEN, R. & GLANZ, K. 2008. Creating healthy food and eating environments: Policy and environmental approaches. *Annual Reviews of Public Health*, 21, 253-72.

STUCKLER, D., MCKEE, M., EBRAHIM, S. & BASU S. 2012. Manufacturing epidemics: The role of global producers in increased consumption of unhealthy commodities including processed foods, alcohol and tobacco. *PLoS Med*, 9, e1001235, doi:10.1371/journal.pmed.1001235.

SWANSON, B. 2008. *Global Review of Good Agricultural Extension and Advisory Service Practices*. Rome, Italy: FAO.

SWINBURN, B., EGGER, G. & RAZA, F. 1999. Dissecting obesogenic environments: The development and application of a framework for identifying and prioritizing environmental interventions for obesity. *Preventive Medicine*, 29, 563-70.

SWINBURN, B.A., SACKS, G., HALL, K.D., MCPHERSON, K., FINEGOOD, D.T., MOODIE, M.L. & GORTMAKER, S.L. 2011. The global obesity pandemic: Shaped by global drivers and local environments. *The Lancet*, 378, 804-14.

TAYLOR, A.L. & JACOBSON, M.F. 2016. *Carbonating the world: The marketing and health impact of sugar drinks in low- and middle-income countries*. Center for Science in the Public Interest. Washington, DC: CSPI.

THE ECONOMIST. 2015. Global population forecasts. Accessed 22 April 2016. http://www.economist.com/blogs/graphicdetail/2015/08/daily-chart-growth-areas.

THE INTERNATIONAL BANK FOR RECONSTRUCTION AND DEVELOPMENT & THE WORLD BANK. 2007. *From agriculture to nutrition: Pathways, synergies and outcomes*. Washington, D.C. World Bank.

THIRTLE, C., LIN, L. & PIESSE, J. 2003. The impact of research-led agricultural productivity growth on poverty reduction in Africa, Asia and Latin America. *World Development*, 31, 1959-1975.

THOW, A.M., ANNAN, R., MENSAH, L. & CHOWDHURY, S.N. 2014. Development, implementation and outcome of standards to restrict fatty meat in the food supply and prevent NCDs: Learning from an innovative trade/food policy in Ghana. *BMC Public Health Journal*, 14, doi:10.1186/1471-2458-14-249.

THOW, A.M. & HAWKES, C. 2009. The implications of trade liberalization for diet and health: a case study from Central America. *Global Health*, 5, doi:10.1186/1744-8603-5-5.

TILMAN, D. & CLARK, M. 2014. Global diets link environmental sustainability and human health. *Nature*, 515, 518-22, doi: 10.1038/nature13959.

TOM, M.S., FISCHBECK, P.S. & HENDRICKSON, C.T. 2015. Energy use, blue water footprint and greenhouse gas emissions for current food consumption patterns and dietary recommendations in the US. *Environment Systems and Decisions*, 36, 92-103.

TOWNSEND, R.F. 2015. *Ending poverty and hunger by 2030: An agenda for the global food system*. Washington, D.C: World Bank.

TRIEU, K., NEAL, B., HAWKES, C., DUNFORD, E., CAMPBELL, N., RODRIGUEZ-FERNANDEZ, R., LEGETIC, B., MCLAREN, L., BARBERIO, A. & WEBSTER, J. 2015. Salt reduction initiatives around the world: A systematic review of progress towards the global target. *PLOS ONE*, 10, e0130247.

TSCHIRELY, D., REARDON, T., DOLISLAGER, M. & SNYDER, S. 2015. The rise of a middle class in East and Southern Africa: Implications for food system transformation. *Journal of International Development*, 27, 628-646.doi:10.1002/jid.3107.

UN DEPARTMENT OF ECONOMIC AND SOCIAL AFFAIRS, POPULATION DIVISION (UN DESA). 2014. *World urbanization prospects: The 2014 revision*. Highlights (ST/ESA/SER.A/352).

UN DESA. 2015. *World population prospects: The 2015 revision, key findings and advance tables*. Working Paper No. ESA/P/WP.241.

UNITED NATIONS STANDING COMMITTEE ON NUTRITION (UNSCN). 2015. Enhancing Coherence between Trade Policy and Nutrition Action. Implementing the Framework for Action of the Second International Conference on Nutrition. Discussion Paper 1. Geneva: UNSCN.

UNITED NATIONS. 2015. Zero Hunger Challenge. Pathways to zero hunger: Transforming our Food Systems to Transform our World. Rome: Committee on World Food Security. Accessed 25 May 2016, http://www.un.org/en/zerohunger/pdfs/ZHC%20-%20Pathways%20to%20Zero%20Hunger.pdf.

UNITED NATIONS. 2016a. Taking the Paris Agreement forward: Tasks arising from decision 1/CP.21. Accessed 26 May 2016. http://unfccc.int/files/bodies/cop/application/pdf/overview_1cp21_tasks_.pdf.

UNITED NATIONS. 2016b. *World economic situation prospects*. New York: United Nations.

UNNEVEHR, L. & GRACE, D eds. 2013. *Aflatoxins: Finding solutions for improved food safety*. 2020 Vision Focus 20. Washington, D.C.: IFPRI.

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES & USDA (U.S. DEPARTMENT OF AGRICULTURE). 2015. *2015–2020 Dietary guidelines for Americans*. 8th edn. Accessed 25 March 2016, http://health.gov/dietaryguidelines/2015/guidelines/.

USDA (UNITED STATES DEPARTMENT OF AGRICULTURE) ECONOMIC RESEARCH SERVICE. 2016. *International macroeconomic data set*. Accessed 20 April 2016, http://www.ers.usda.gov/data-products/international-macroeconomic-data-set.aspx.

VANDEVIJVERE, S. & SWINBURN, B. 2015. Pilot test of the healthy food environment policy index (Food-EPI) to increase government actions for creating healthy food environments. *British Medical Journal Open*, 5:e006194.

VANDEVIJVERE, S., MONTEIRO, C., KREBS-SMITH, S.M., LEE, A., SWINBURN, B., KELLY, B., NEAL, B., SNOWDON, W., SACKS, G. & INFORMAS (International Network for Food and Obesity). 2013. Monitoring and benchmarking population diet quality globally: A step-wise approach. *Obesity Reviews*, 14 Suppl 1, 135-49, doi: 10.1111/obr.12082.

VANHAM, D., MEKONNEN, M.M. & HOEKSTRA, A.Y. 2013. The water footprint of the EU for different diets. *Ecological indicators*, 32, 1-8. doi:10.1016/j.ecolind.2013.02.020.

VILLORIA, N.B., GOLUB, A., BYERLEE, D. & STEVENSON, J. 2013. Will yield improvements on the forest frontier reduce greenhouse gas emissions? A global analysis of oil palm. *American Journal of Agricultural Economics*, 95, 1301-1308.

VON BRAUN J. & KENNEDY E. 1994. *Agricultural Commercialization, Economic Development and Nutrition*. Baltimore, MD: Johns Hopkins University Press.

VON BRAUN, J. & TADESSE, G. 2012. Global food price volatility and spikes: An overview of costs, causes and solutions. ZEF-Discussion Papers on Development Policy, Bonn.

WARREN, E., HAWKESWORTH, S. & KNAI, C. 2015. Investigating the association between urban agriculture and food security, dietary diversity and nutritional status: A systematic literature review. *Food Policy*, 31, 54-66, doi:10.1016/j.foodpol.2015.03.004.

WCRF (WORLD CANCER RESEARCH FUND). 2016a. *Set retail environment incentives. Set incentives and rules to create a healthy retail and food service environment.* Accessed 20 June 2016, http://www.wcrf.org/int/policy/nourishing-framework/set-retail-environment-incentives.

WCRF. 2016b. NOURISHING framework – Our policy framework to promote healthy diets and reduce obesity. Accessed 5 April 2016, http://www.wcrf.org/int/policy/nourishing-framework.

WEI, A. & CACHO, J. 2001. Competition among foreign and Chinese agro-food enterprises in the process of globalization. *International Food and Agribusiness Management Review*, 2, 437-451.

WHEELER, T. & VON BRAUN, J. 2013. Climate change impacts on global food security. *Science*, 341, 508-13.

WHITING, D.R., GUARIGUATA, L., WEIL, C. & SHAW, J. 2011. IDF diabetes atlas: Global estimates of the prevalence of diabetes for 2011 and 2030. *Diabetes Research and Clinical Practice*, 94, 311-21.

WHITMEE, S., HAINES, A., BEYRER, C., BOLTZ, F., CAPON, A.G., DE SOUZA DIAS, B.F., EZEH, A., FRUMKIN, H., GONG, P., HEAD, P., et al. 2015. Safeguarding human health in the anthropocene epoch: Report of The Rockefeller Foundation-Lancet Commission on planetary health. *Lancet*, 386, 1973-2028.

WHO, UNICEF (CHILDREN'S RIGHT and EMERGENCY RELIEF ORGANIZATION), USAID, AED (ACADEMY FOR EDUCATIONAL DEVELOPMENT), UC DAVIS (UNIVERSITY OF CALIFORNIA DAVIS) and IFPRI. 2010. *Indicators for assessing infant and young child feeding practices. Part 3 Country Profiles*. Geneva: WHO.

WHO. 2010. NLIS (Nutrition Landscape Nutrition Information System) Country profile indicators interpretation guide. Geneva: WHO.

WHO. 2014. *World report on ageing and health*. Geneva: WHO.

WHO. 2015a. *Healthy diets*. Fact Sheet 394. Accessed 20 February 2016, http://www.who.int/mediacentre/factsheets/fs394/en/

WHO. 2015b. *WHO estimates of the global burden of foodborne diseases: Foodborne disease burden epidemiology reference group 2007–2015*. Geneva: WHO.

WIGGINS, S. & KEATS, S. 2015. *The Rising Cost of a Healthy Diet: Changing Relative Prices of Foods In High-Income and Emerging Economies*. London, UK: ODI.

WINA (WORLD INSTANT NOODLES ASSOCIATION) 2016. The manufacturing process of instant noodles. Accessed 20 June 2016, http://instantnoodles.org/en/noodles/process.html.

ZHU, J., ZHANG, Y., XUE, H., WANG, L., WANG, Y. & WANG, Y. 2016. Trends in obesity and non-communicable chronic diseases in China and projected future situation for 2030. *The Official Journal of the Federation of America Societies for Experimental Biology*, 30, lb421.

Appendices

APPENDIX 1: TABLE 1.1: Recent reports on food systems: Aims and key messages

Product category	Aim	Key messages
Bioversity International. 2012. Metrics of Sustainable Diets and Food Systems, 2012[286]	To develop metrics to define the sustainability of a food system	Food system sustainability involves measuring: nutrition adequacy, environmental sustainability, cultural acceptability, low cost-accessibility
FAO. 2013. The State of Food and Agriculture: Food Systems for Better Nutrition[287]	To provide an overview of how food systems must be used to ensure better nutrition	Consumers ultimately determine what they eat and therefore what food systems produce. Within a multisectoral approach, food systems offer many opportunities for interventions to improve nutrition, including better governance
Global Panel. 2014. "How can agriculture and food system policies improve nutrition?"[288]	To identify policy actions that support nutrition-enhancing food systems as a whole	Governments must move away from policy that is focused on just one or another part of the system at a time. Policies should focus on agricultural production, markets and trade, purchasing power, food transformation and consumer demand
ILSI. 2014. Assessing Sustainable Nutrition Security: Role of Food Systems, 2014[289]	To generate metrics of the influence of the food system on sustainable nutrition security	Food systems impact on nutrition from production to retailing, to consumption and waste disposal. Metrics are available to model these
FAO. 2014. High Level Panel of Experts. Food Losses and Waste in the Context of Sustainable Food Systems[290]	To analyze existing evidence about the causes of food losses and waste (FLW) and suggests action to reduce them	(1) Improve data collection and knowledge sharing on food loss and waste (FLW); (2) Develop effective strategies to reduce FLW, at the appropriate levels; (3) Take effective steps to reduce FLW – at micro, meso and macro (systemic) levels; (4) Improve coordination of policies and strategies in order to reduce FLW
US National Research Council. 2015: Committee on a Framework for Assessing the Health, Environmental and Social Effects of the Food System[291]	US focus (1) facilitate understanding of environmental, health, social and economic effects of food systems, (2) encourage improved data collection systems and methodologies to identify and measure effects; (3) inform decisions in food/ agricultural practices and policies to minimize unintended health, environmental, social and economic consequences	Develop a framework for assessing the health, environmental and socio-economic effects of the US food system. Most studies evaluating food system strategies are too narrow and do not look at multiple dimensions – using a comprehensive framework to assess food systems uncovers hidden advantages/disadvantages
Chicago Council. 2015. "Healthy Food for a Healthy World"[292]	To identify what the US government can do to make nutrition-sensitive policy interventions across the food system value chain	Stronger policies, more research, training for the next generation of leaders, public private partnerships needed for nutrition-sensitive food systems
International Panel of Experts on Sustainable Food Systems. 2015. The New Science of Sustainable Food Systems: Overcoming Barriers to Food Systems Reform[293]	To make the case for producing a joined-up picture of food systems and their political economy, in ways that reach across the scientific disciplines and reach beyond traditional bounds of the scientific community	A comprehensive definition of sustainability which should be used an end goal of food systems
World Bank. 2015. Ending poverty and hunger by 2030: an agenda for the global food system[294]	What are the key actions in food systems that must be taken to end widespread hunger?	Three areas with greatest impact: 1) climate-smart agriculture; 2) improving nutrition (agriculture needs to become more nutrition-sensitive); and 3) strengthening value across food chains and improving market access

Source: Compiled by the authors

[286]Fanzo, Cogill and Mattei (2012) [287]FAO (2013) [288]Global Panel (2014) [289]Acharya et al. (2014) [290]HLPE (2014) [291]IOM and NRC (2015) [292]Bereuter and Glickman (2015) [293]IPES-Food (2015) [294]Townsend (2015)

APPENDIX 1: TABLE 1.1 (continued): Recent reports on food systems: Aims and key messages		
IFPRI. 2016. Global Food Policy Report[295]	How can food systems (support for smallholder farmers) best contribute to meeting UN Sustainable Development Goals?	Support for smallholders: invest in agricultural R&D, efficient and inclusive value chains, increased equality of access to and control of land, increase women's access to inputs, better water and irrigation management, climate smart agriculture and climate finance
WWF Netherlands report. 2016. The Global Food System: an Analysis[296]	To explore if the world can achieve a food system that works within the planet's biophysical boundaries, inclusively supports human livelihoods, and ensures food security for a growing and changing population?	The world needs to address four main challenges simultaneously in order to transition to a sustainable and resilient food system: creating an adaptive and resilient food system; making nutritious food available to all; working within planetary boundaries; while supporting livelihoods and well-being
Source: Compiled by the authors		

APPENDIX 2: TABLE 3.1: Initiatives to improve food consumption quality and availability				
Food consumption measurement initiative	**Host organizations**	**Number of countries**	**Type of data**	**Level of aggregation**
Global Dietary Database http://www.globaldietarydatabase.org/the-global-dietary-database-measuring-diet-worldwide.html	Tufts University	113 approximately	Population and individual-based dietary surveys	National and some subnational
Global Individual Database on Food Intake (GIFT) (under development)	FAO and WHO	Not clear	Individual food intake	National and some subnational
Voices of the Hungry. The Food Insecurity Experience Scale	FAO and Gallup	150 approximately	Experiential estimates of food insecurity. Self-reported data collected at the individual level.	National and some subnational
Comprehensive European Food Consumption Database http://www.efsa.europa.eu/en/food-consumption/comprehensive-database	European Food Safety Authority	22 European Member States	Individual-based dietary surveys	National and some subnational
Global Consumption Database http://datatopics.worldbank.org/consumption/AboutDatabase	World Bank	90 approximately	Food expenditure for 35 food and beverage categories from household surveys	National and some subnational
Passport Nutrition http://www.euromonitor.com/passport-nutrition	Euromonitor	54 countries	Retail sales of foods	National
Source: Compiled by the authors				

[295]IFPRI (2016) [296]Gladek et al. (2016)

APPENDIX 3: TABLE 3.2: 'healthy' and 'unhealthy' categories used by Imamura et al. (2015) and what they mean

Diet component	Why 'healthy'/'unhealthy'
'Healthy'	
Fruits (100 g/serving)	↓ Coronary heart disease (CHD), ↓ stroke, ↓ oesophageal cancer, ↓ lung cancer
Vegetables, including legumes (100 g/serving)	↓ CHD, ↓ stroke, ↓ oesophageal cancer
Nuts/seeds (1 oz (28.35 g)/serving)	↓ CHD, ↓ diabetes
Wholegrains (50 g/serving)	↓ CHD, ↓ diabetes
Seafood (100 g/serving)	↓ CHD, ↓ stroke
'Unhealthy'	
Red meat, unprocessed (100 g/serving)	↑ diabetes, ↑ colorectal cancer
Processed meat (50 g/serving)	↑ CHD, ↑ diabetes, ↑ colorectal cancer

Source: Compiled by the authors, based on Micha et al. (2015), Table 2

APPENDIX 4: TABLE 3.3: Definitions of categories of processed foods, non-alcoholic beverages and ultra-processed foods in Chapter 3

Product category	Description	Included as ultra-processed
(1) Total processed foods	**Aggregation of all processed food categories**	
Baked goods	Bread, pastries and cakes	✓*
Biscuits and snack bars	Sweet biscuits, savoury biscuits and crackers and bread substitutes, granola/ muesli bars, breakfast bars, energy and nutrition bars, fruit bars	✓
Breakfast cereals	Ready-to-eat and hot cereals	✓
Cheese	Processed and unprocessed cheese*	✓*
Confectionery	Chocolate confectionery, chewing gum and bubble gum, and sugar confectionery	✓
Dried processed food	Dessert mixes, dried ready meals, dehydrated soup, instant soup, dried pasta, plain noodles, instant noodles and rice products	✓
Milk products	Fresh/pasteurized, long-life, goat, flavoured milk drinks, soya beverages, milk powder	
Ice cream and frozen desserts	Impulse ice cream, take-home ice cream, frozen yoghurt, artisanal ice cream and other frozen desserts	✓
Oils and fats	Vegetable/seed oil, cooking fats, butter, margarine, spreadable oils/fats	
Processed fruits and vegetables	Shelf stable fruits and vegetables and frozen fruits and vegetables	
Processed meat and seafood	Processed meat, processed seafood and meat substitutes	✓*
Ready meals	This is the aggregation of canned/preserved, frozen, dried, chilled ready meals, dinner mixes, frozen pizza, chilled pizza and prepared salads.	✓
Sauces, dressings and condiments	Tomato pastes/purees, bouillon/stock, herbs/spices, monosodium glutamate (MSG), table sauces, soya-based sauces, pasta sauces, wet/cooking sauces, dry sauces/powder mixes, ketchup, mayonnaise, mustard, salad dressings, vinaigrettes, dips, pickled products	✓
Soup	Canned/preserved, dehydrated, instant, chilled, UHT and frozen soup	✓
Spreads	Jams and preserves, honey, chocolate spreads, nut based spreads, and yeast based spreads	✓
Sweet and savoury snacks	Fruit snacks, chips/crisps, extruded snacks, corn chips, popcorn, pretzels, nuts	✓
Yoghurt and sour milk products	Yoghurt and sour milk drinks	✓*
(2) Total non-alcoholic beverages	**Aggregation of all non-alcoholic beverage categories**	
Bottled water	Still bottled water, carbonated bottled water, flavoured bottled water and functional bottled water	
Carbonated soft drinks	Non-alcoholic drinks containing dissolved carbon dioxide, regular & low calorie	✓
Concentrates	Liquid concentrates and powder concentrates	✓
Ready-to-drink coffee & tea	Packaged ready-to-drink (RTD) coffee and tea, excluding coffee flavoured milk drinks	✓
Fruit/vegetable juice	100% juice, nectars (25-99% juice), juice drinks (< 24% juice), flavoured drinks	✓
Sports & energy drinks	Sports and energy drinks	✓

Source: Baker (2016)
Note: The categories included as 'ultra-processed' are consistent with the PAHO (2015) NOVA food classification system, however, due to the unavailability of more disaggregated data the categories marked with a '*' aggregate several processed and ultra-processed categories and are subsequently over-represented in the total ultra-processed categorization.

APPENDIX 5: TABLE 6.1: The world's top 25 food and non-alcoholic beverage companies (2003, 2010 and 2015)

Company	Main product line	Food sales (million USD)			Rank		
		2003	2010	2015	2003	2010	2015
Nestlé S.A.	Diversified	61,615	91,560	72,245	1	1	1
PepsiCo Inc.	Beverages and snack foods	26,971	43,232	66,683	6	2	2
JBS	Meat	–	12,745	52,580	–	13	3
The Coca-Cola Company	Beverages	21,044	30,990	45,998	8	6	4
Archer Daniels Midland Co.	Ingredients, grain-based products	36,151	32,241	43,232	2	5	5
Tyson Foods	Meat and poultry	24,549	26,704	37,580	7	9	6
Kraft Foods Inc./Mondelez Int. (2015)	Diversified	31,010	40,386	34,244	3	3	7
Cargill Inc.	Grain-based foods	27,260	26,500	33,700	5	10	8
Mars Inc.	Confectionery	17,000	30,000	33,000	9	7	9
Unilever plc	Diversified	29,938	29,180	29,070	4	8	10
Danone	Dairy, biscuits, water	14,850	20,810	28,545	10	11	11
H. J. Heinz Co./Kraft Heinz (2015)	Frozen and shelf-stable foods	8,415	10,155	28,000	18	24	12
Lactalis	Dairy	6,051	11,805	22,240	31	18	13
Fonterra Cooperative Group	Dairy	6,575	10,025	18,565	25	26	14
General Mills Inc.	Grain-based foods	11,070	14,691	17,910	12	12	15
ConAgra Inc.	Diversified	14,522	12,731	17,703	11	14	16
Royal FrieslandCampina	Dairy	4,866	11,335	15,320	34	19	17
Kellogg Co.	Grain-based foods	8,812	12,575	14,580	17	16	18
CHS Cooperatives	Grain-based foods	4,177	6,550	14,500	41	44	19
Grupo Bimbo S.A. de C.V.	Baked goods	3,530	8,628	14,390	52	33	20
Arla Foods Group	Dairy	6,068	9,710	14,330	30	28	21
Smithfield Foods Inc.	Processed meats	8,248	12,488	13,221	19	17	22
BRF Brasil Foods	Frozen foods	–	8,093	13,185	–	35	23
NH Foods Ltd.	Meat, processed foods, dairy, marine products	–	–	12,108	–	–	24
Ferrero	Confectionery	–	8,900	11,355	–	31	25

Source: Compiled by the authors, based on Food Engineering (2016)
Note: Alcoholic beverage companies have been removed.

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ISBN:978-0-9956228-0-7

September 2016

Download the full report
and executive summary here:
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Jointly funded by

UKaid
from the British people

Bill & Melinda Gates foundation

This report is based on research funded in part by the UK Government and the Bill & Melinda Gates Foundation. The findings and conclusions contained within are those of the authors and do not necessarily reflect positions or policies of the funders