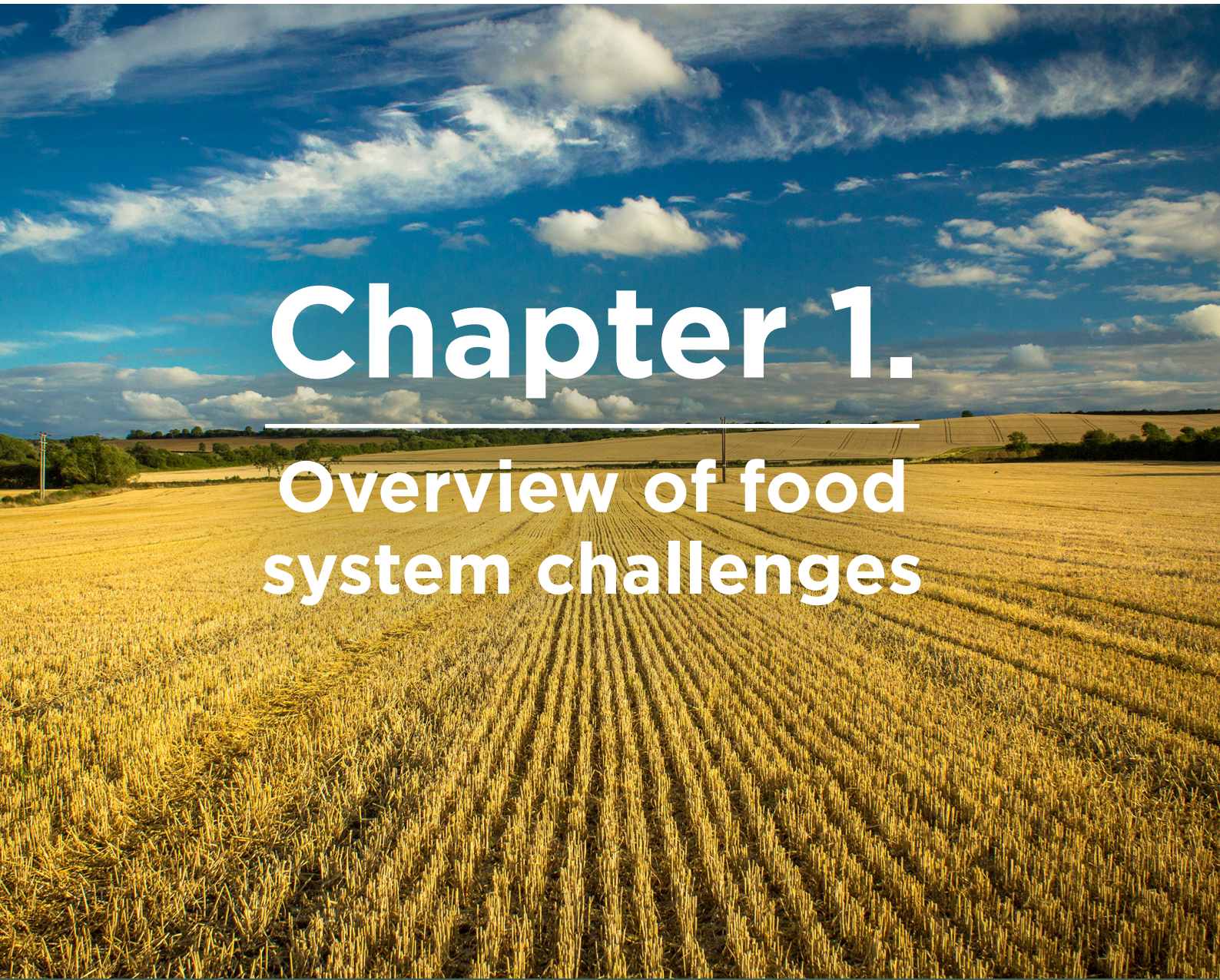
FCRN
Food Climate Research Network

fondation
daniel & nina carasso
sous l'égide de la Fondation de France

FCRN foodsource

A free and evolving resource to empower informed discussion on sustainable food systems



Chapter 1.

Overview of food system challenges

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Why should you read this chapter?

How food gets to our plates and what happens afterwards, connects many issues of concern, including health, biodiversity, climate change, livelihoods, and more.

This means that by acting to change how food is produced, distributed, consumed, and disposed of, we can also affect these outcomes — either for better or for worse. However, to understand the implications of potential changes, we must understand how all these factors are interconnected and affect one another. In other words, we need to apply systems thinking to food.

This chapter, and associated resources, provides an entry point into 'food systems' thinking and the multifaceted set of issues that are connected through food. It provides a foundation for the wider set of ideas and complexities that are explored in the other chapters of Foodsource.

The chapter addresses the following:

- What is meant by the term food system?
- What are the major issues of concern linked to food systems?
- How can a food systems approach help us to address these more effectively?

Key points

- Food affects social, economic, moral, and environmental concerns in complex ways. To understand how, we need to adopt a systems thinking perspective.
- The whole 'food system' encompasses all the interconnections and interactions – spanning time and geographic space – between food, natural resources, people, organisations, government, organisms, the climate, and more.
- But such complexity is overwhelming. In practice, food systems thinking divides up this interconnected whole and makes judgements about which parts and interconnections are the most important for understanding the causes of things.
- Food systems interact with the environment in multiple ways, including as major sources of greenhouse gase emissions and as contributors to water and air pollution, biodiversity loss, deforestation, desertification, and land degradation.
- The food system interacts with people and society via health (e.g. malnutrition, infectious disease), livelihoods (e.g. employment and subsistence), consumption growth (e.g. driven by diets and population), and is shaped by power relations (e.g. gender, wealth, political and economic relations).
- Food systems are shaped by, and in turn influence, cultural, social and ethical concerns, including traditional practices and cultural norms; social identity; moral concerns about animal welfare and rights; religion and spirituality; art; and as part of shared experiences and enjoyment in social life.
- Because food is a point of interconnection linking social, economic, and environmental concerns, by understanding these interconnections, common solutions can sometimes be found that address multiple issues simultaneously.
- To be truly sustainable, food systems must operate within environmentally sustainable limits and at the same time, must also provide for basic human needs for nutrition, employment, health, and more.
- What sustainable food systems actually look like is still unclear, although our understanding is continuously growing.

1.1 What are food systems?

1.1.1 Food systems can be conceptualised in many ways

Food systems can be conceptualised in a great many ways; the sheer number and variety of diagrams illustrates food system complexity.

A set of processes

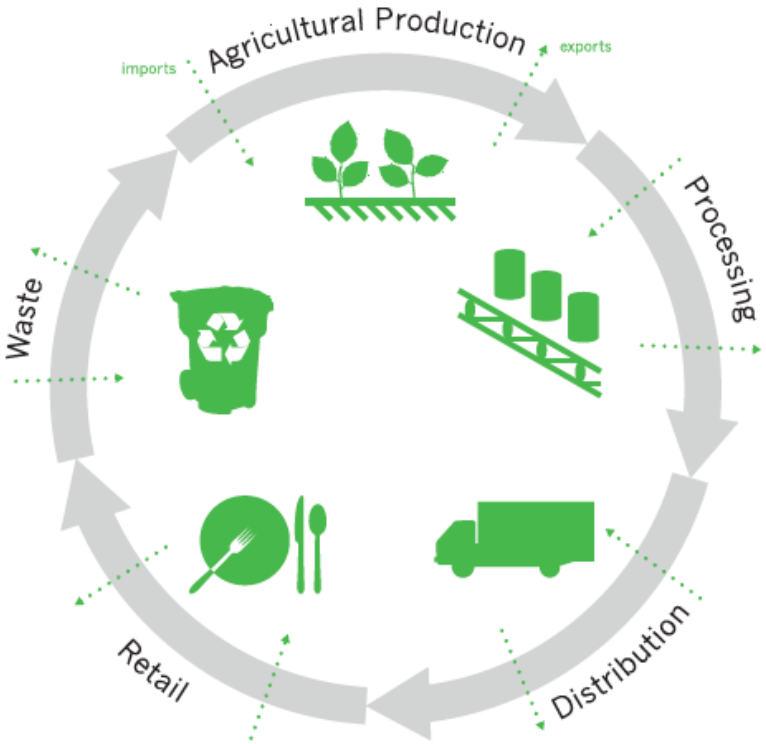

Figure 1: A circular representation of processes within the food system.

Source: Rodin, Carsten. (2013). Figure 1: Defining the Regional Food System. Retrieved from http://www.spur.org/publications/urbanist-article/2013-05-13/grow-eat-compost-repeat.

At the most basic level, the food system may be considered to be the set of processes that occur between field and fork. Sometimes, this is shown as a linear sequence, while in many other cases, as here, the food system is considered to be at least partly cyclical.

This form of food system diagram, while perhaps informative at an immediate level, has very limited uses, as it fails to convey such crucial components of food systems as drivers (that is, influences on food system activities and outcomes) and actors (that is, the set of stakeholders involved in, and which influence the food system).

Processes and external influences

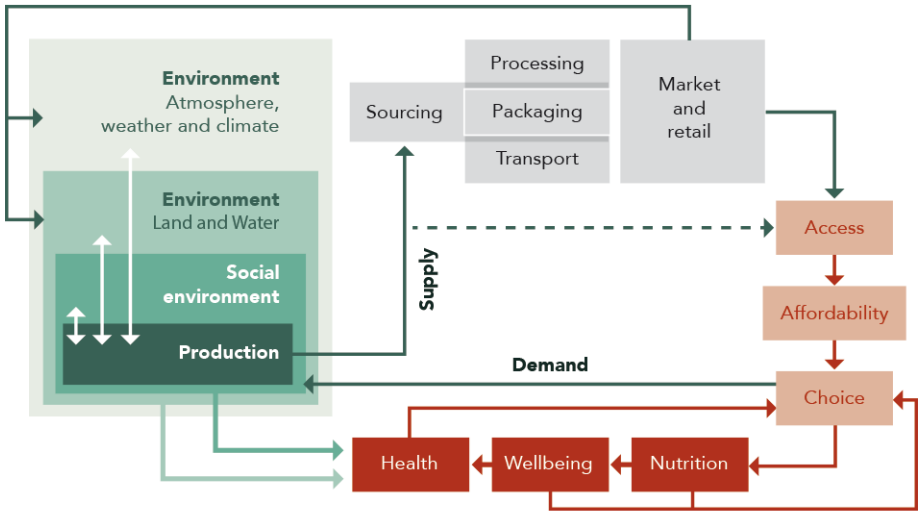

Figure 2: A food system diagram showing some social and environmental influences on the food system.

Source: Benton, Tim. (unknown). Figure adapted from teaching materials provided by the author.

This diagram indicates a small number of social influences on certain aspects of the food system, and shows the main food system activities, but it does not encompass the full range of cultural factors, actors and drivers involved in the system.

Incorporating drivers and outcomes

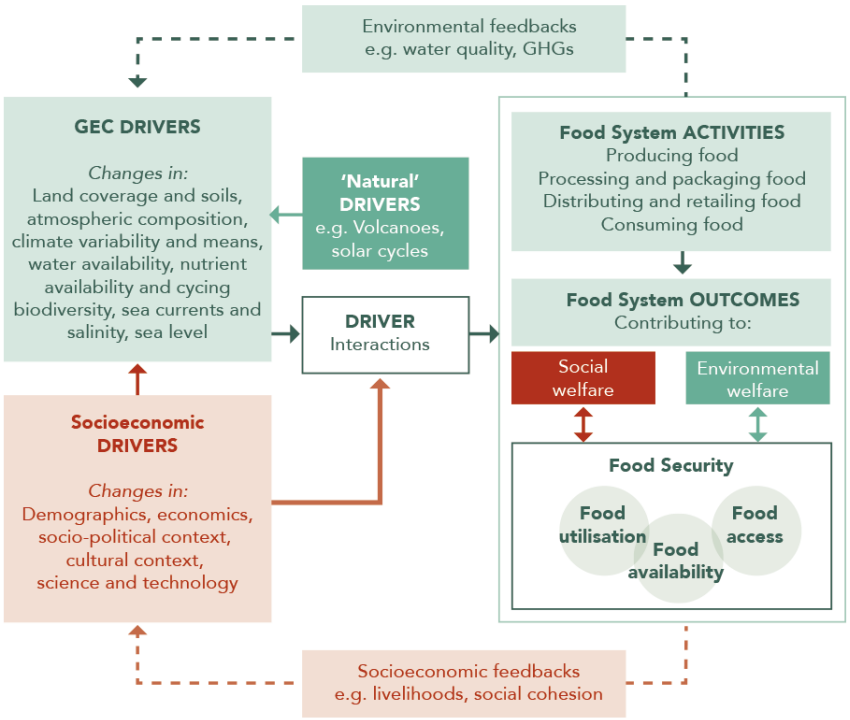

Figure 3: A food system diagram showing drivers of change and relationship with food system outcomes.

Source: Ingram, J., Ericksen, P. and Liverman, D. (eds) (2010). *Food Security and Global Environmental Change*, London, Earthscan.

This diagram takes an almost opposite approach to the above, detailing the many different drivers and outcomes of the food system, but neither placing this in the context of the physical food system activities, nor showing the actors in the food system.

All-encompassing

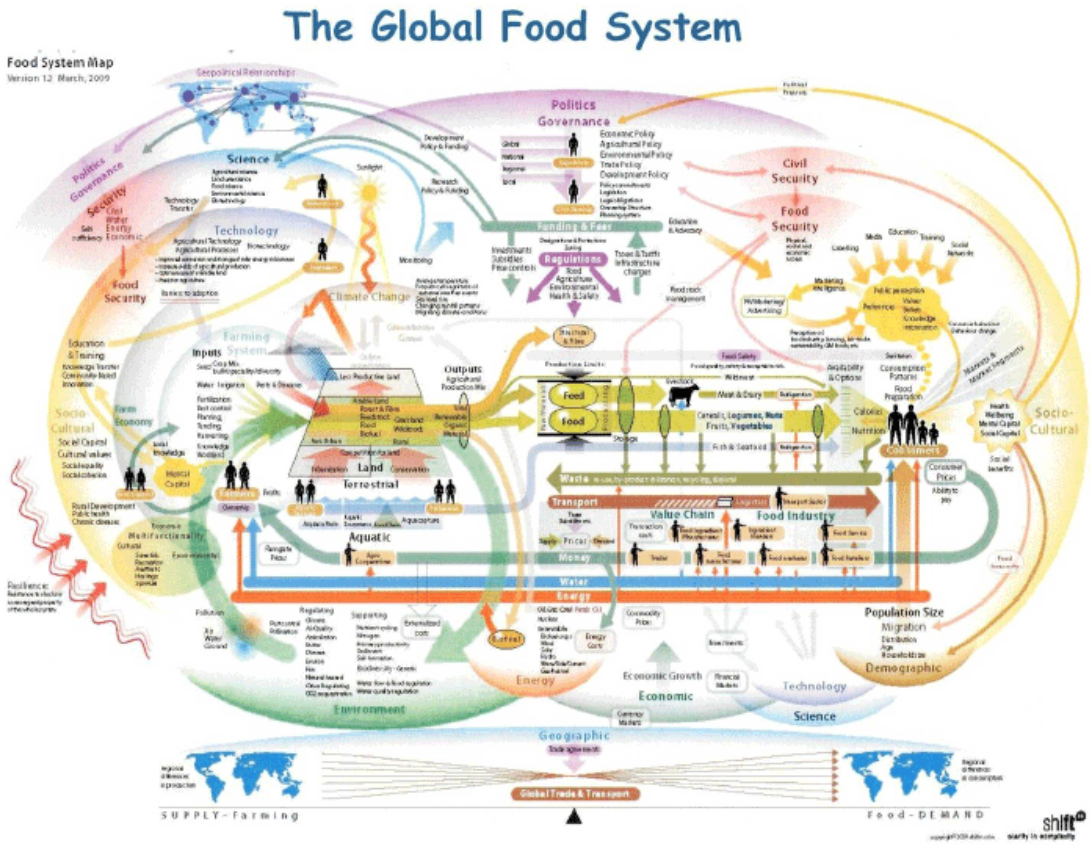

Figure 4: A comprehensive illustration of the global food system.

Source: ShiftN. (2016). Global food system map. Retrieved from https://www.slideshare.net/pvandenbroeck/global-food-system-map-57053271.

This diagram, by contrast with those above, contains a vast wealth of detail – however, it is arguably so all-encompassing as to be unintelligible.

Simplified for comprehension but holistic in scope

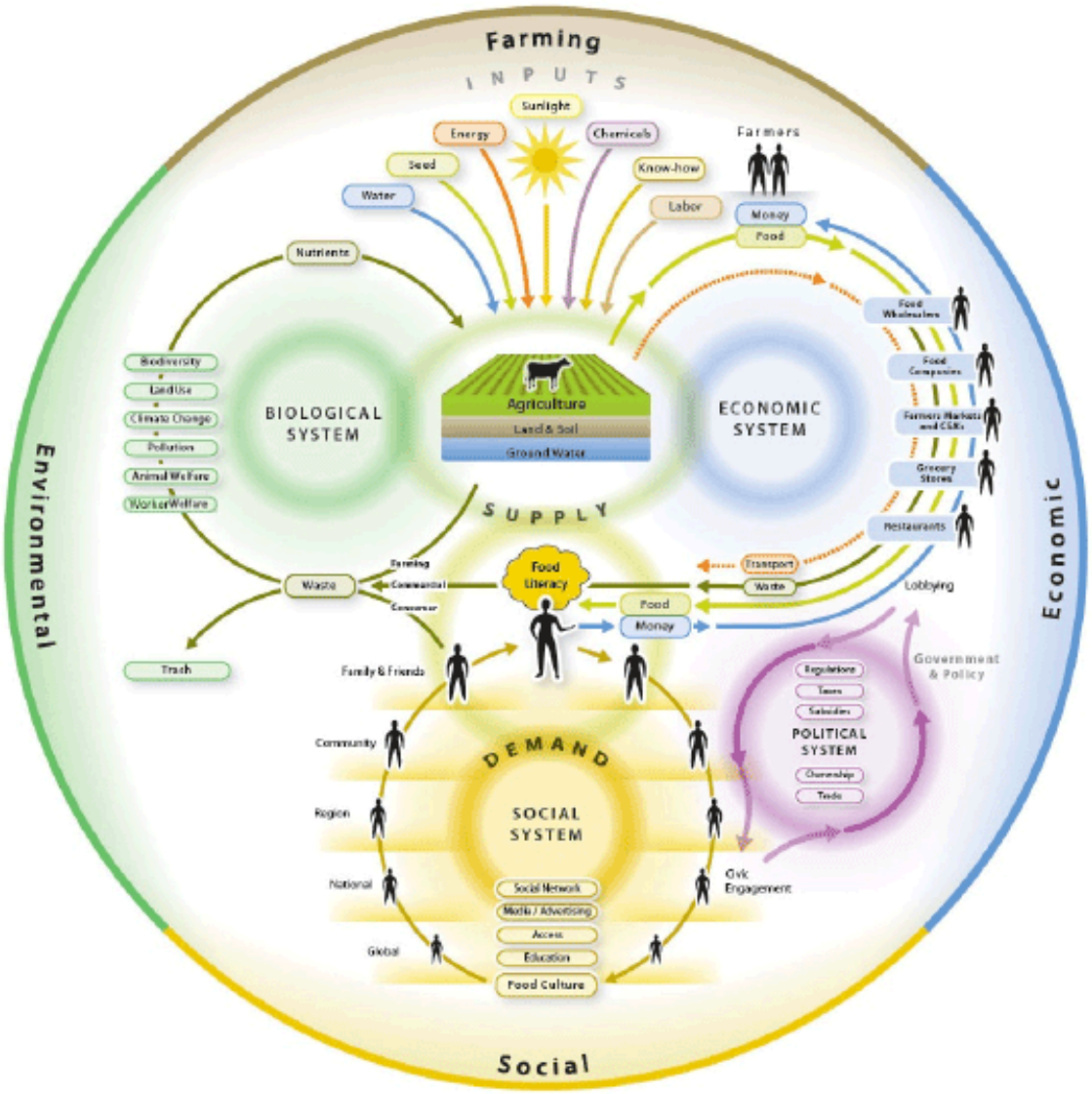

Figure 5: A simplified but holistic food system diagram.

Source: ShiftN. (2016). Global food system map. Retrieved from https://www.slideshare.net/pvandenbroeck/global-food-system-map-57053271.

This could be argued to be one of the most useful food systems diagrams (or "maps") available. It encompasses physical supply chain processes; actors and activities; direct and indirect drivers (and different facets thereof); and inputs and outputs.

1.1.2 Food systems are dynamic

Food systems can be understood on a great many spacio-temporal scales, but at any scale, food systems are dynamic

Food system dynamics encompass social, economic and biophysical interactions across multiple dimensions:

- The physical flow of goods from agriculture through to consumption and waste disposal;
- The social, economic, political, environmental, cultural and other forces that influence and shape this flow;
- The social, economic, political, environmental, cultural and other consequences that result from this flow of goods; and
- The interactions between consequences and drivers, that is, the way in which the dynamic interactions of the food system can shape its future direction.

Supply chains refer to the processes (production, processing, distribution, retail) that may be involved before food reaches our plates. Supply chains operate at both global and local levels. They can operate at: local-to-local, local-to-global, global-to-local and global-to-global scales.

Another term that is often used is the 'value chain' – the latter takes into account not just the flow of products but also the actors involved at each stage and the value (financial or reputational or other) that these actors add, via processing or distribution for example, to the final good.

Gómez and Ricketts (2013) have characterised the various value chains in existence as: traditional, modern, modern-to-traditional, and traditional-to-modern.

Food systems encompass the suite of activities and actors, as well as the environmental, socio-economic, and governance drivers and influencers of these activities and actors. Feedback loops exist among socio-economic drivers (such as population change), global environmental drivers (such as changes in soil fertility), governance (regulations, standards) food systems activities and outcomes, all of which together impact upon food security (see Chapter 7 for more on food security). The food security status of a given population will in turn act as a driver – influencing for example, new governance arrangements, new food producing activities and so forth.

In reality, there is no single 'food system' but rather multiple 'food systems' operating at different spatial or social scales, which interact with one another to varying degrees.

Food security

Food security is an idealised state or goal where all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life.

1.2 How do food systems link multiple issues and concerns?

Environmental and socioeconomic interactions are complex

Food acts as a focal point for multiple social, ethical, environmental, and health interactions and concerns.

A food systems approach recognises that diverse social, economic, and environmental outcomes often have common causes.

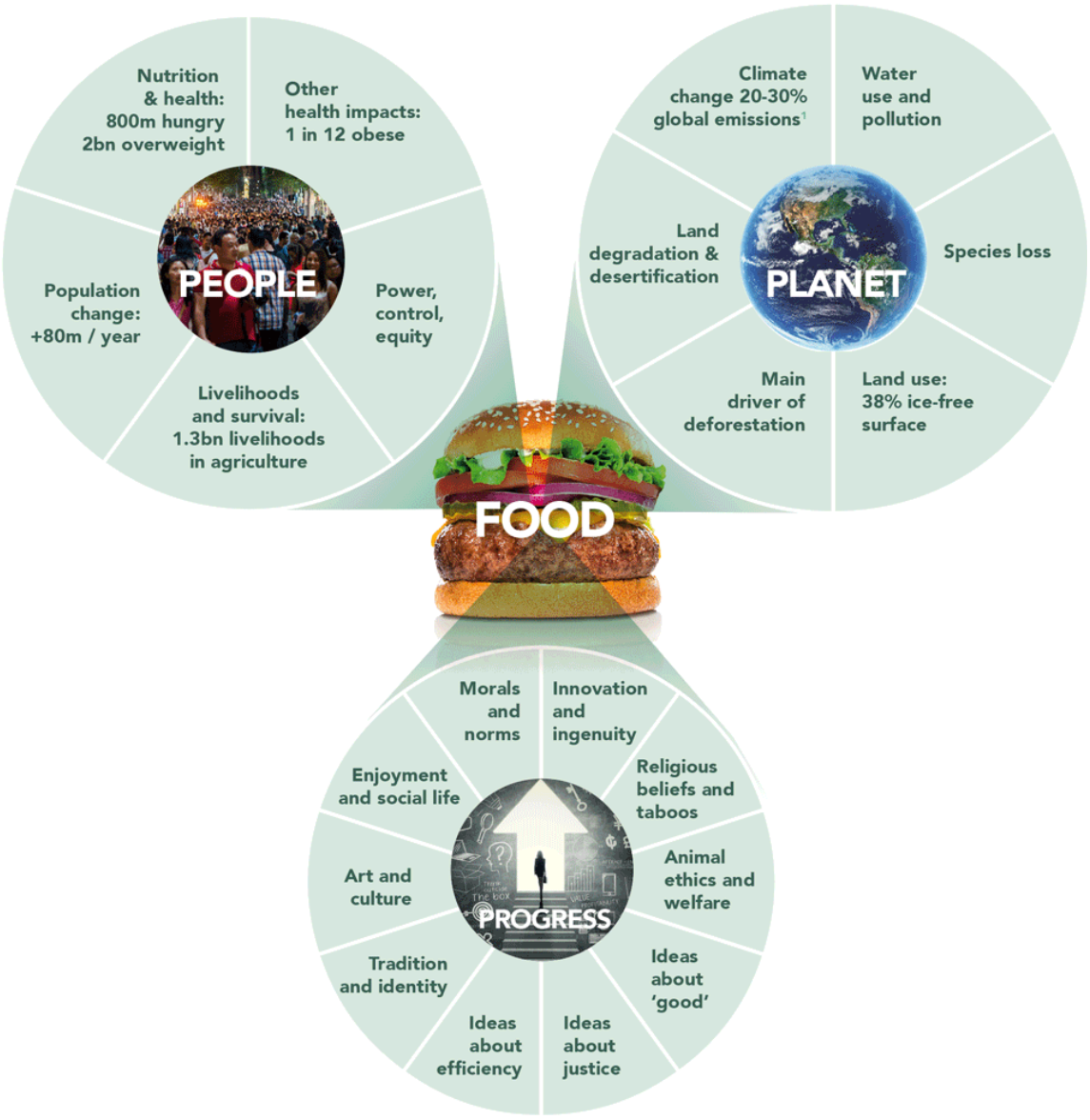

Figure 6: Connection between food systems and other issues and concerns.

Source: FCRN. (2016).

1.3 What are the relationships among food systems and environmental change?

1.3.1 Food system interactions with the environment

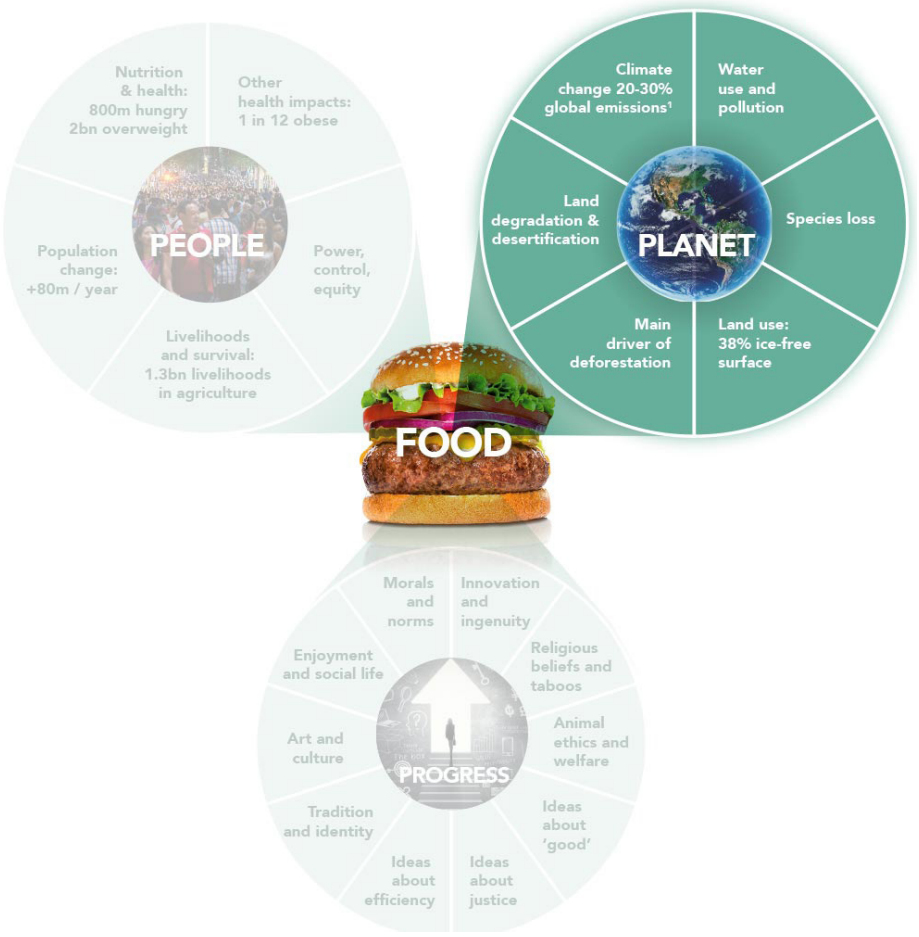

Figure 7: Connection between food systems and the environment.

Source: FCRN. (2016).

The food system as a whole – including agricultural production and agriculturally induced land-use change, transport, storage and food preparation – contributes around 20-30% of global human-made greenhouse gas (GHG) emissions. See Chapter 2 for more on how these impacts can be quantified, and Chapter 3 for more on the greenhouse gas emissions from food systems.

Food systems are also important causes of rising scarcity, species loss and land degradation. A substantial amount of the food produced is lost or wasted along the supply chain, causing significant problems. See Chapter 5 for more on these topics.

GHGs

GHGs is an abbreviation for greenhouse gases. These include gases such as carbon dioxide, methane, and nitrous oxide, which are released as a result of human activity, and which trap heat within the earth's atmosphere, leading to global warming.

1.3.2 Food systems as a major source of climate changing greenhouse gas (GHG) emissions

Global perspective – food systems contribute about 20–30% of GHGs

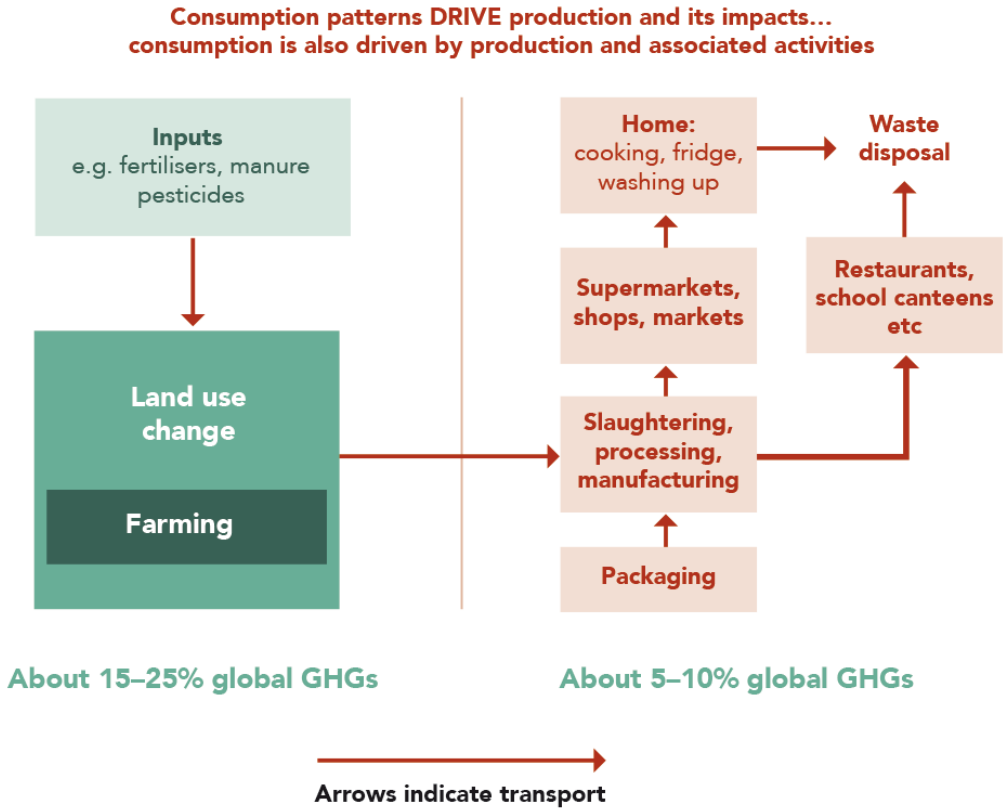

Figure 8: Food system greenhouse gas emissions from production and post-production activities.

Source: Vermeulen, S.J., Campbell, B.M. and Ingram, J.S.I. (2012) *Climate Change and Food Systems. Annual Review of Environment and Resources*. 37, 195-222.

The food system is estimated to contribute approximately 20–30% of global human-made GHGs, although there is huge inherent uncertainty in these estimates.

The major impacts come from farming/agriculture and land-use change (see the previous slide), with fertilisers, pesticides, manure, farming and land-use change together contributing as much as around 24% of global GHGs. Livestock alone contribute 14.5% of human-made GHG emissions

Stages later in the food system such as packaging, retail, transport, processing, food preparation and waste disposal combined contribute around 5–10% of global GHGs although their importance and likely impacts are set to grow.

These stages are discussed in more detail later in this chapter.

Within food systems, consumption patterns and production are interrelated, both impacting on one another. These topics are discussed more in Chapter 4.

1.3.3 Food systems as a cause of other environmental problems

Biodiversity loss from agricultural production and expansion

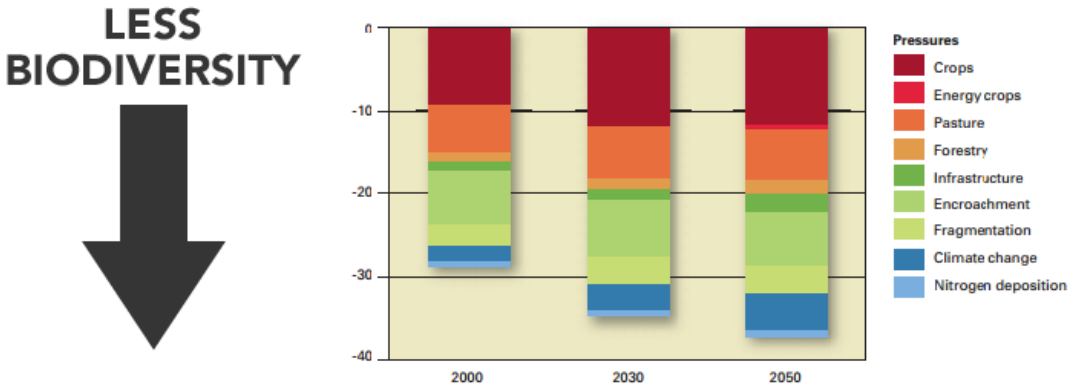

Figure 9: Projection of future pressures and associated biodiversity loss in the UK under a business as usual scenario.

Source: NEAA (2010). Rethinking Global Biodiversity Strategies: Exploring Structural Changes in Production and Consumption to Reduce Biodiversity Loss. Netherlands Environmental Assessment Agency, The Hague, the Netherlands. In: FAO (2011) *Biodiversity for food and agriculture. Contributing to food security & sustainability in a changing world*. (Published by UNFAO and the Platform for Agrobiodiversity Research).

Without action, increased demand for food, and in particular for resource-intensive foods such as meat, will lead to significant and continued biodiversity losses. This would primarily arise from agricultural expansion into new areas to grow crops (often to feed livestock); from the creation of new pasture lands; and from the encroachment on and fragmentation of ecosystems. Note that a degree of uncertainty exists around population growth, demand for food, and how food production responds to these changes. For discussions about expected population change, see later in this chapter and Chapter 4 and Chapter 7.

These biodiversity losses could be modified or reduced by: increasing the extent of protected areas; through yield increases in food production; better forest management; by actions to moderate demand for resource-intensive food consumption and to reduce waste; and by limiting climate change. Some of these mitigation options are explored in Chapter 4, in relation to addressing greenhouse gas emissions.

Fish stocks are under increasing pressure

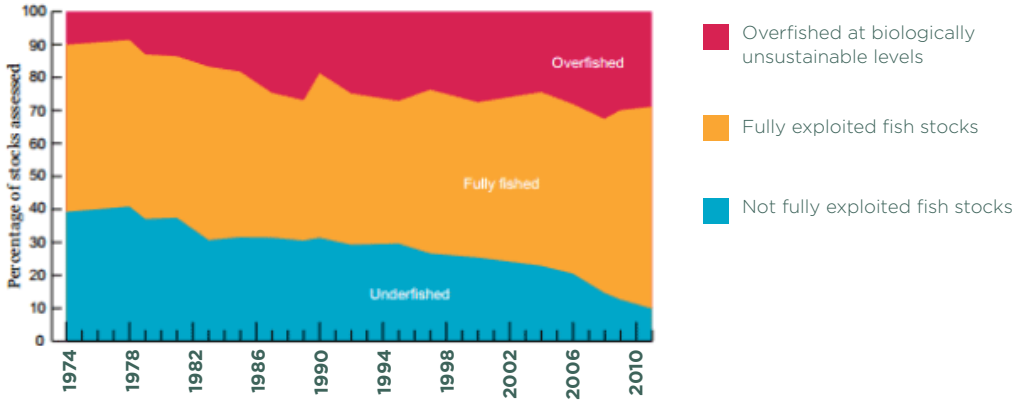

Figure 10: Global trends in the state of marine fish stocks 1974–2011.

Source: WWF (2015). *Living Blue Planet Report – Species, habitats and human well-being*, WWF International.

The last 50 years have seen dramatic reductions in wild fish stocks, due mainly to over-fishing and destructive fishing techniques by humans. Around 85% of fisheries are now fully exploited or overfished, with 29% of marine fisheries being overfished. Marine vertebrate populations declined 49% between 1970 and 2012.

Fish are an important food source and nearly 3 billion people rely on fish as their major source of protein. Fisheries, therefore, need to be protected on grounds of 'self interest' – to safeguard global food security – as well as for intrinsic environmental reasons.

Other environmental damage to marine ecosystems includes the increase in oxygen-depleted dead zones, resulting from nutrient run-off from agriculture, and loss of coral ecosystems and mangrove systems. Some of the mangrove loss is a consequence of aquaculture (seafood farming) although the influences are diverse and changing. See later in this chapter for more on aquaculture.

Only 3.4% of the oceans are protected.

Certification of sustainable fisheries does exist, although global coverage is not high and illegal fishing continues.

1.3.4 Climate change influences on food supply, availability and quality

There are also huge uncertainties in how climate change will impact future food productivity.

Much depends on the interplay between temperature increase, the effect of increased CO_2 on plant growth, extreme events (drought, flooding), and water supply and its use. We also need to consider climate change impacts on economic development, trade, transport and logistics infrastructure, population migration, food prices and much more.

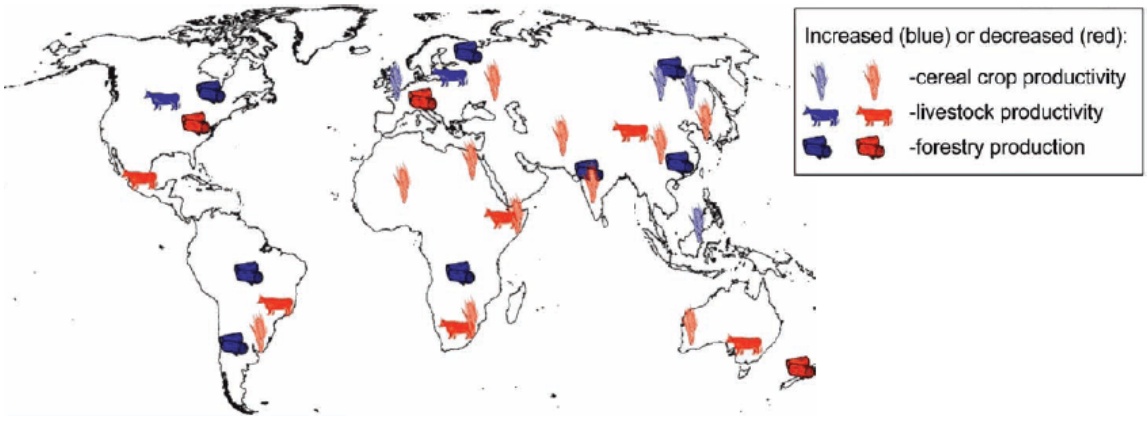

Figure 11: Major impact of climate change on crop and livestock yields and forestry production by 2050, based on literature and expert judgement (not including adaptation).

Source: Easterling, W.E., Aggarwal, P.K., Batima, P., Brander, K.M., Erda, L., Howden, S.M., Kirilenko, A., Morton, J., Soussana, J.-F., Schmidhuber, J. and Tubiello, F.N. (2007), Food, fibre and forest products(link is external). Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 273-313.

Mangrove

A mangrove is a salt tolerant tree or shrub that grows in tidal and coastal wetlands and swamps, typically in tropical and sub-tropical regions. They typically form mangrove forests and are globally important for biodiversity and carbon storage, and also for their role in coastal protection.

Aquaculture

Aquaculture refers to the breeding, rearing and harvesting of animals and plants in aquatic environments.

A gradual warming may benefit Northern countries, initially, by expanding the range of crops that can be grown and lengthening growing seasons. But beyond 2050, the negative impacts of climate change are likely to outweigh any benefits. The impacts on Southern (poor) countries are already starting to hit home and to be negative. These impacts are predicted to worsen over time. Poor people in lower-income countries who are less able to adapt and who are already vulnerable in multiple social and economic ways, will likely suffer most.

1.4 How does food interface with societal and health concerns?

1.4.1 Food system interactions with health and society

Populations and dietary patterns are changing

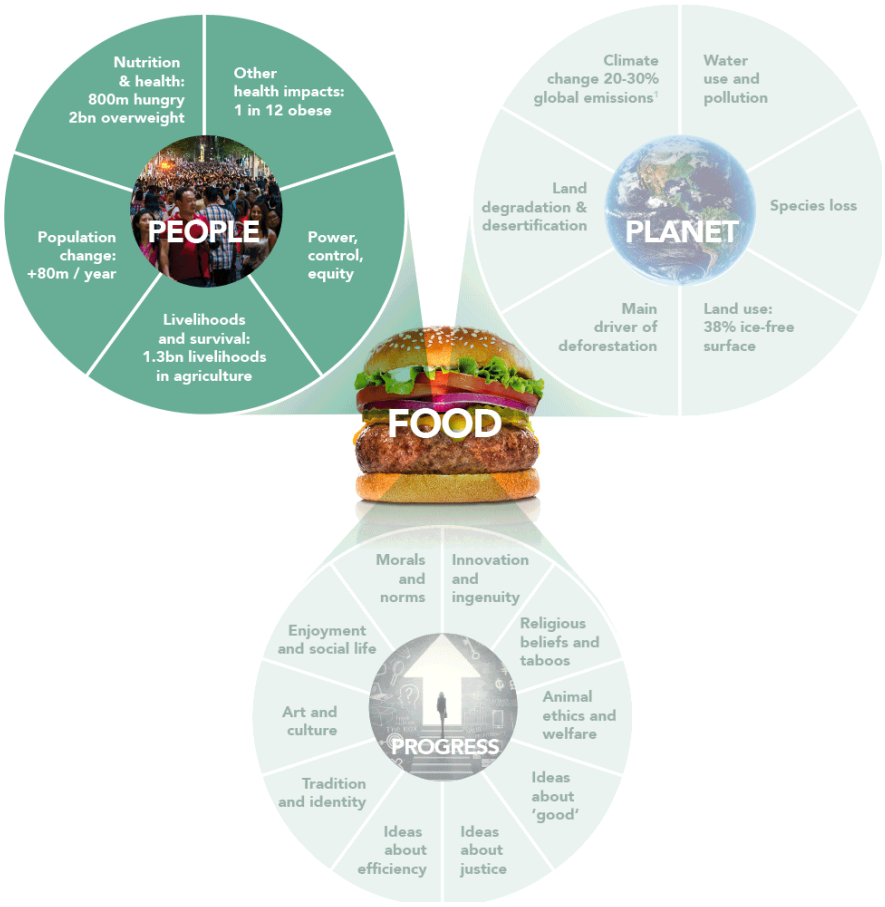

Figure 12: Connection between food systems and human issues.

Source: FCRN. (2016).

Large numbers of people are employed in agriculture and post-harvest industries. In low-income countries, and particularly in Sub Saharan Africa, a dominant percentage of the population continues to rely on agriculture and associated rural activities for their livelihoods.

The global population is growing, and diets are changing. These trends, the link between food and health, the health implications of changing dietary patterns, and understanding about what constitutes a healthy sustainable diet are issues covered in Chapter 7, Chapter 8 and Chapter 9.

1.4.2 Persistence of inequality and its contribution to malnutrition in all its forms

Contrasts and inequalities

Figure 13: Contrasts and inequalities in relation to food and people.

Source: FCRN. (2016).

Malnutrition exists in many forms. It manifests itself in the form of:

- Excessive consumption of energy and nutrients (leading to overweight, obesity, and diseases of excess);
- Protein and energy deficiencies (leading to hunger, underweight, and stunting); and
- Micronutrient deficiencies which cause a range of problems, including iron deficiency anaemia, birth defects, and osteoporosis, to name but a few.

These various forms of malnutrition coexist within and across communities. Large numbers of people are still chronically undernourished, while globally, obesity is on the rise and causes a range of health problems. Poor diets can also lead to non-communicable diseases such as type 2 diabetes, heart disease and strokes, independently of the link with obesity.

Micronutrient deficiencies affect billions of people across the world, and across the weight spectrum.

At the same time, the global population is still growing, at a rate of around 80 million per year. The population is not just growing but also urbanising – more than half the world's population now lives in urban areas.

Micronutrient deficiencies

Micronutrient deficiencies result from a diet lacking the essential vitamins and minerals that humans require in small amounts for proper growth, development, and bodily functioning. These include iodine, calcium, iron, zinc, and vitamins A, B, and C, among others. Micronutrient deficiencies are the cause of a range of diseases affecting physical and mental development, and can increase susceptibility to infectious diseases.

Non-communicable diseases

Non-communicable diseases are those that are non-infectious and so non-transmissible between people. They generally have a long duration and progress slowly. Examples include cardiovascular diseases (e.g. heart attack and stroke), cancer, diabetes and chronic respiratory diseases (e.g. asthma).

.Nearly 20% of the global population are still engaged directly or indirectly in food production for their livelihoods, but much of the industry is controlled by a small number of stakeholders. This control affects how the food system functions. This has implications for small scale producers, processors, retailers and caterers; it influences the types of foods that are marketed and available – and their price – and it influences what changes in consumer habits might be possible. The influences on consumption and the options for shifting them are covered in more detail in Chapter 10.

1.4.3 Changing populations and dietary patterns

Growing population: 9–10bn by 2050

Changing population:

- Urbanisation: 54% of global population is urban, 66% by 2050.
- Africa & Asia urbanising fastest.
- Young in some areas, ageing in others, globalising.

Rising (average) incomes leading to:

- Changing lifestyles.
- Dietary changes, with trend towards "Western diet": "the nutrition transition" (see Chapter 7 for more).
- Changing burden of diseases (e.g. increased obesity, heart disease, strokes, diabetes and some cancers).

But: There is persistent poverty.

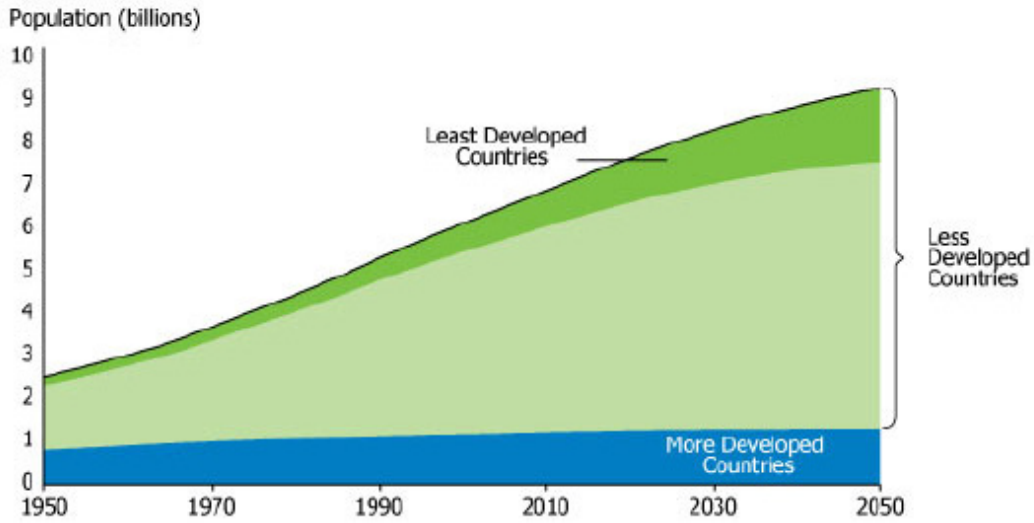

Figure 14: World populations projections 1950 to 2050: Division between countries according to development.

Source: United Nations Population Division. (2011). World population prospects: the 2010 revision.

The global population now stands at over 7 billion, and is predicted to reach 9–10 billion by 2050. Additionally, our eating patterns are changing, with a shift towards greater quantities of animal products in the diet. See Chapter 4, Chapter 7 and Chapter 8 for more on this.

Per capita demand for major food commodities will increase by 2050

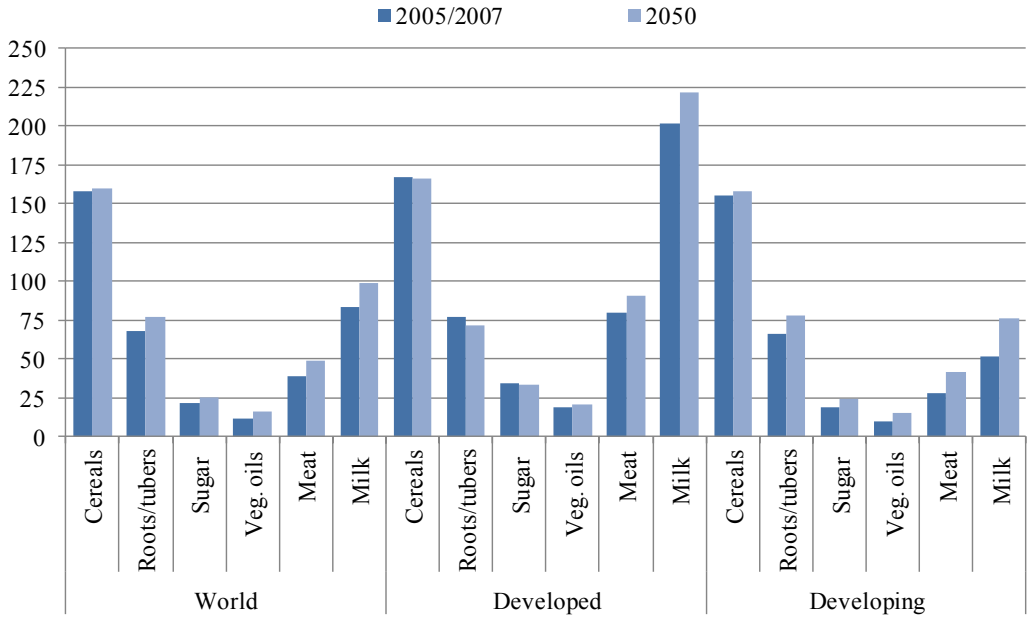

Figure 15: Food consumption per capita of major commodities (kg/person/year): 2005/2007 and 2050 projection.

Source: Alexandratos, N. and Bruinsma, J. (2012) World agriculture towards 2030/2050: the 2012 revision. ESA Working paper No. 12-03. Rome, FAO.

Based on current trajectories, with rising incomes in developing countries, global food consumption per capita is projected to rise.

In developed countries, meat consumption is not expected to rise much further, if at all, since intakes are already high. The majority of the increase will be in developing countries. (For more on meat consumption see Chapter 4 and Chapter 8).

The FAO predicts that, in order to feed the world's growing population, food production will need to increase by 60%, and that the demand for meat will nearly double, by 2050.

Some organisations challenge the 'need' for this increase – e.g. see Soil Association (2010). For more on this dispute, see Chapter 4.

FAO

The Food and Agriculture Organisation is a specialised agency of the United Nations. It is dedicated to leading international efforts to defeat hunger worldwide.

Increased demand for food is predicted to continue

Predicted growth in production up to 2050

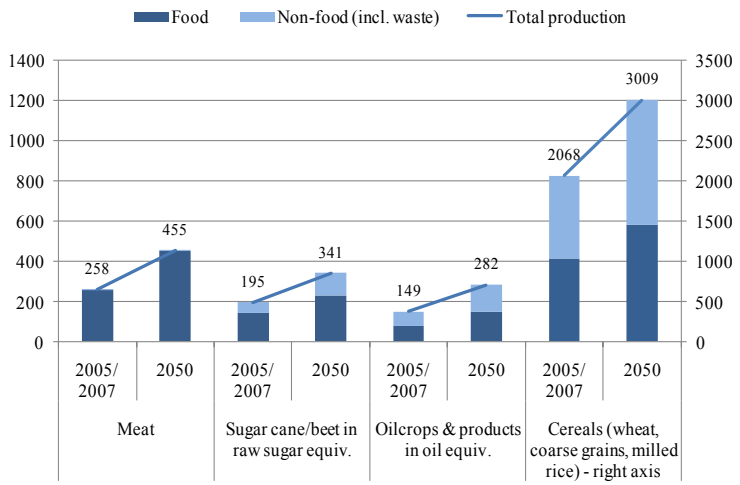

Figure 16: Projected growth in agricultural commodity production: 2005/2007 and 2050 projection.

Source: Alexandratos, N. and Bruinsma, J. (2012) World agriculture towards 2030/2050: the 2012 revision. ESA Working paper No. 12-03. Rome, FAO.

1.5 What about the relationship between food, culture, ethics and social norms?

Food system interactions with culture, ethics and social norms

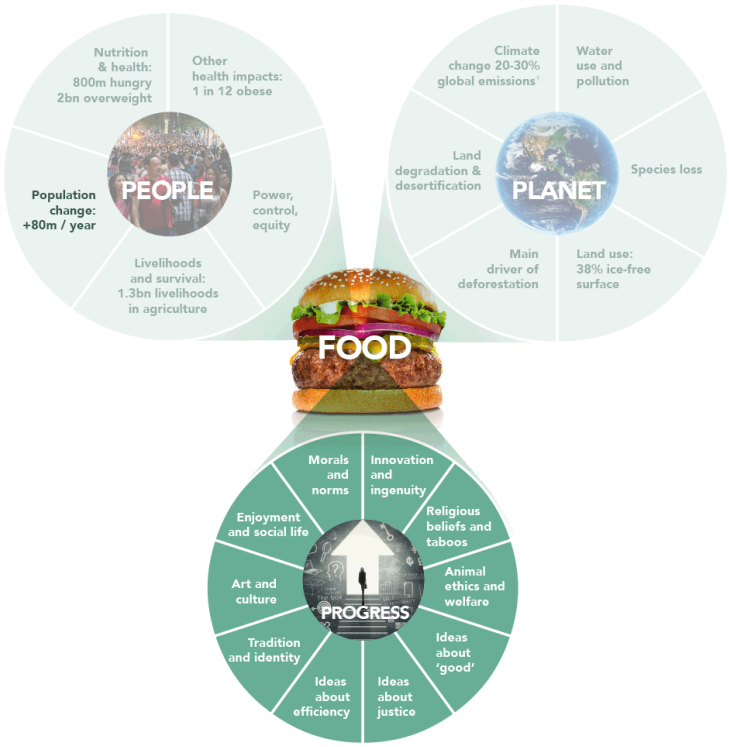

Figure 17: Connection between food systems and human values.

Source: FCRN. (2016).

Different groups within societies have different beliefs about food, shaped by their ideas about tradition, identity, social norms, and justice. One example of where religion and beliefs strongly influence diets is India. Vegetarianism is an integral part of most schools of Hinduism and most Hindus restrain from eating beef. Importantly, different stakeholders and groups may also have interests and influences that clash with one another, and this is the source of a great deal of disagreement as to how food system problems should be addressed. See Chapter 8 for more on this.

1.6 How might these challenges be addressed?

1.6.1 Food as a 'nexus' issue

- Food is a nexus issue, connecting many different concerns and challenges.
- This connectedness suggests a need to address issues in an integrated way, rather than only focusing on one issue or one stage in the food system (such as food production).
- Integrated approaches can potentially create synergistic outcomes, with benefits both for the environment and people.
- But there are many stakeholders involved, with many different views and interests. Some interest groups will lose out, and there will always be trade-offs that will need to be managed.

1.6.2 Food and the 'planetary boundaries' concept

The planetary boundaries approach aims to define a safe operating space for human societies, based on an understanding of the functioning and resilience of the Earth as a system. Nine key boundaries have been defined, relating to land-use, biodiversity, water use, GHG emissions and more . The boundaries themselves are not absolute lines that cannot be crossed, but zones with increasing risk of irreversible damage and potential tipping points, beyond which the earth system destabilises, resulting in planetary conditions outside of what human civilisation has developed within, making humans continued existence difficult, if not impossible.

The planetary boundaries concept

Climate change is considered to be one of the boundaries that is at "increasing risk" of being exceeded – and food systems are a major contributing cause. Land-use and biodiversity are "increasing or high risk" (see Chapter 5 for more information on the influence agriculture has on deforestation and biodiversity). Furthermore, boundaries relating to biochemical flows (which includes both nitrogen and phosphorus – both indispensable to current systems of agricultural production) are considered "high risk

There is inherent uncertainty within such an approach, not least because it cannot account for unforeseen technological advances that may mitigate human impacts, but there is a general consensus that the planetary boundaries concept provides a useful model for assessing environmental risk.

Planetary boundaries concept

The planetary boundaries concept refers to the idea that humans are substantially altering natural systems, and that beyond a certain level of change this may become irreversible and self sustaining. The potential result is a planet with environmental conditions that differ substantially from those in which human civilisation developed and to which many species and ecosystems are adapted. Planetary boundaries have so far been proposed for climate change, biodiversity loss, biogeochemical cycles, ocean acidification, land use, freshwater, and ozone depletion.

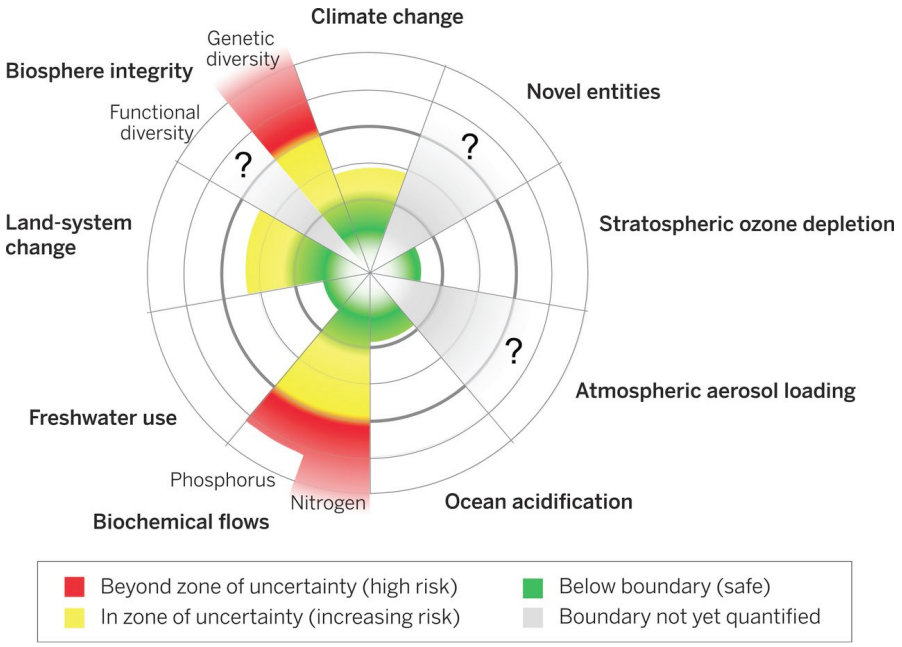

Figure 18: Planetary boundaries: estimated tipping points for changes in earth system functioning in relation to current human influence.

Source: Steffen, W., Richardson, K., Rockström, *et al*. (2015). Planetary Boundaries: Guiding Human Development on a Changing Planet. *Science*, 347 (6223).

1.6.3 Food and 'doughnut economics'

We need to balance environmental and social concerns

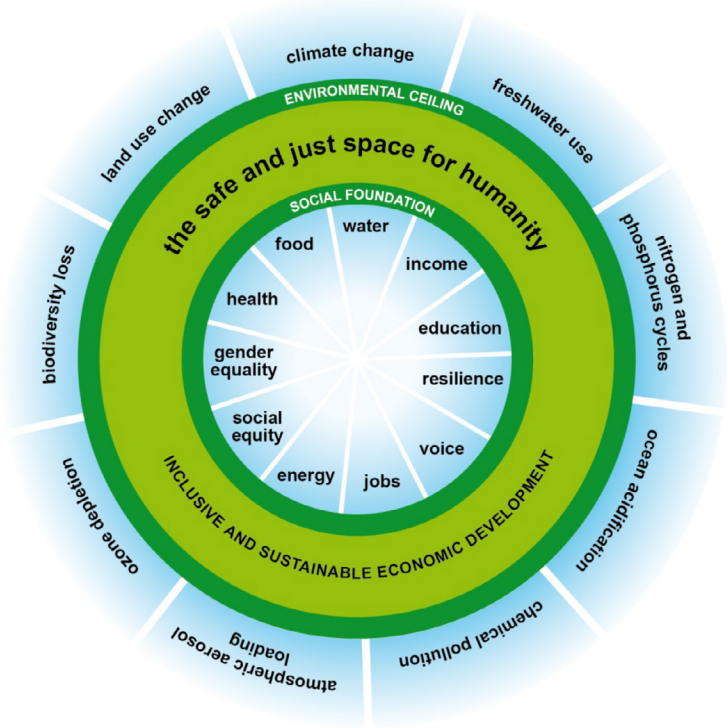

Figure 19: The doughnut economics concept: a sustainable zone within planetary boundaries and a socio-economic foundation.

Source: Raworth, K. (2012). *A Safe and Just Space for Humanity*. Oxfam Discussion Paper.

The doughnut economics concept developed by Oxfam takes the planetary boundaries concept discussed previously and builds on it by adding a minimum level of resource use below which human society will suffer hunger, ill-health and poverty. There is thus a need to stay above this minimum resource use threshold (i.e. the 'social foundation') and below the environmental ceiling (as defined by the planetary boundaries concept). The space between these two limits is described as the "safe and just space for humanity".

As such, both social and environmental factors are combined into a single framework.

In reality, the social foundation is not a fixed threshold, because people have different visions on what constitutes a 'safe and just' space, and a 'good' life.

1.7 Conclusions

This chapter illustrates how food raises many interlinked environmental and socio-economic problems and shows that projections are for increased pressure on all fronts.

An integrated food systems approach is needed to understand and tackle these challenges, recognising the interactions and dynamics of the system and that there are often common causes behind the diverse social, economic and environmental outcomes.

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