

Approaches to Fixing Broken Food Systems



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Robyn Alders

Faculty of Veterinary Science, University of Sydney, Australia. *Healthy Food Systems: Nutrition, Diversity, Safety* Project Node, Charles Perkins Centre and Marie Bashir Institute (CPC/MBI), University of Sydney, Australia. Kyeema Foundation, Brisbane, Australia and Maputo, Mozambique



Julian Cribb

Healthy Food Systems: Nutrition, Diversity, Safety Project Node, Charles Perkins Centre and Marie Bashir Institute (CPC/MBI), University of Sydney, Australia. Julian Cribb and Associates, Canberra, Australia



Mike Nunn

Healthy Food Systems: Nutrition, Diversity, Safety Project Node, Charles Perkins Centre and Marie Bashir Institute (CPC/MBI), University of Sydney, Australia. Australian Centre for International Agricultural Research, Canberra



Richard Kock

Healthy Food Systems: Nutrition, Diversity, Safety Project Node, Charles Perkins Centre and Marie Bashir Institute (CPC/MBI), University of Sydney, Australia. Royal Veterinary College, University of London, Hatfield, Hertfordshire, United Kingdom



Brigitte Bagnol

Faculty of Veterinary Science, University of Sydney, Australia. *Healthy Food Systems: Nutrition, Diversity, Safety* Project Node, Charles Perkins Centre and Marie Bashir Institute (CPC/MBI), University of Sydney, Australia. Kyeema Foundation, Brisbane, Australia and Maputo, Mozambique. The University of the Witwatersrand, Department of Anthropology, Johannesburg, South Africa



Jonathan Rushton

Healthy Food Systems: Nutrition, Diversity, Safety Project Node, Charles Perkins Centre and Marie Bashir Institute (CPC/MBI), University of Sydney, Australia. Royal Veterinary College, University of London, Hatfield, Hertfordshire, United Kingdom



“Sustainable development is not an option! It is the only path that allows all of humanity to share a decent life on this, one planet. Rio+20 gives our generation the opportunity to choose this path.”

Sha Zukang, Secretary-General of the Rio+20 Conference.

Key messages

Everyone on the planet belongs to one and the same ecosystem. Improved health and wellbeing for the world’s population and better stewardship of the planet can be achieved by recognizing that adequate food and nutrition is a human right. Improved nutrition can be achieved by a variety of means. These include:

- Developing diets that are appropriate for individuals, taking into account a variety of factors such as age, gender and health status
- Increasing food resilience and counteracting losses in biodiversity by promoting greater diversity in the range of foods produced and consumed

- Playing a more active part in curating efficient nutrient cycling (or ecological recycling)
- Taking steps to maintain soil fertility, soil availability and the quality of fresh water.
- Encouraging the development of nutrition-sensitive value chains that deliver food with a high “cost-to-nutritional-benefit” ratio and support sustainable agricultural and distribution systems and
- Defining and facilitating sustainable and ethical food systems that contribute to human and planetary health – among the greatest challenges facing our world today.

1. Sustainable agricultural production

Between 2016 and 2050, when the world’s population is expected to reach 9 billion, it will be necessary to produce as much food as has been produced during the entire existence of *Homo sapiens* on this planet. However, the “broken” food systems of today have delivered the double burden of under- and overnutrition, led to the degradation of ecosystems, and reduced many farming families to impoverishment. Within these broken systems, women carry most of the burden of health problems and poverty. Focusing on good nutrition and the encouragement of efficient nutrient cycles can help strengthen

interrelationships between farmers, traders, regulators, consumers and policy-makers, thereby helping to generate policies that support food systems that deliver sustainable, diverse and nutritious diets that meet the individual needs of everyone and limit negative agricultural effects on biodiversity and ecosystem health. This chapter reviews the West’s historical and physiological relationship with food, examines how food is produced and distributed, and presents a range of options for making food choices that are beneficial both for people and for the planet.

Previous page: Pastoralism shows a remarkable degree of integration between livestock and people, with the welfare of animals on a par with that of the people. The nutritional benefits to the South Sudan tribes are obvious, with some of the most physically well developed human beings on the planet.

Modern livestock production in the developed world is highly intensive. The sustainability of this model is attracting increasing scrutiny. Source: Fiedel Ammann

“It is not enough to produce more. If societies are to flourish in the long term, they must produce sustainably. The past paradigm of input-intensive production cannot meet the challenge. Productivity growth must be achieved through sustainable intensification. That means, *inter alia*, conserving, protecting and enhancing natural resources and ecosystems, improving the livelihoods and wellbeing of people and social groups and bolstering their resilience.” FAO (Food and Agriculture Organization of the United Nations) 2014

Figure 1 | **Global dietary patterns among men and women in 187 countries in 2010**

Values represent degrees of adherence to each dietary pattern, ranging from 0 (least healthy) to 100 (most healthy).

Dietary patterns based on more healthy items



Dietary patterns based on fewer unhealthy items



Overall dietary patterns



Source: Imamura et al., *Dietary quality among men and women in 187 countries in 1990 and 2010: a systematic assessment*. *Lancet Global Health*. 2015;3(3):e132-42.

2. Sustainable food systems for the planet's dominant consumers

From earliest times, wildlife played a critical role in the emergence of earth's most successful mammalian species, *Homo sapiens*. Exploitation of wild food by means of hunting and gathering was the main evolutionary driver for humans, and was critical to our species' nutritional health and growth.

During the past 10,000 years, the growing human population has been sustained through the domestication of various animal species and the development of agricultural systems, as well as by continued hunting, fishing and foraging. These activities have been industrialized to a greater or lesser extent in the effort to achieve increased food output per unit of scarce resource. The economic logic of this approach has major unintended consequences for the planet, particularly where key resources are inappropriately valued. Many aspects of the world's current food systems are less than optimal. In some instances, they are actually undermining the long-term food security and health of the Earth and the people who inhabit it.

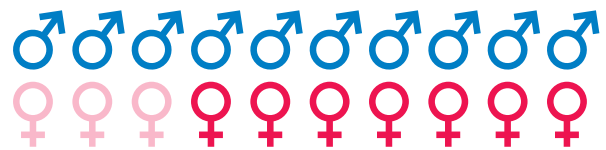
A number of new trends give cause for concern, including an unprecedented loss of biodiversity; a concomitant reduction in ecological resilience; the emergence of newly identified infectious and non-infectious diseases; and a rise in global ambient temperatures that is triggering climate change worldwide. Directly and indirectly, human behavior has driven many of these trends, underpinned by widespread adoption of Western-style consumption patterns across vast swathes of the globe. People have become increasingly estranged from nature through a process of

urbanization that has disconnected urban communities from rural food-producing communities, and wealthier nations have become disassociated from poorer nations, despite the fact that the world is more interconnected than ever by modern technology and transport. Food producers have lost their link to both food consumers and the environment, and vital, nutrient-rich foods have been debased to the status of commodities to be traded in a highly volatile global marketplace.

Gender inequities are also increasingly being recognized as a major social determinant of health and nutritional outcomes, as well as of reduced agricultural production. For example, in Sub-Saharan Africa women play a dominant role in the production, processing and post-harvest storage of food, yet only 15% of landholders are women. Women are also less likely than men to benefit from credit and extension services.

Figure 2 | The yield gap between men and women farmers and its impact on productivity

The yield gap between male and female farmers averages about **20-30%**, mostly due to differences in resource use.



Given equal access to resources as men, women would achieve the same yield levels, boosting total agricultural output in developing countries by **2.5-4%**.



Source: FAO (2014).



Human beings are the world's dominant consumers.
Source: Mike Bloem

Food systems include the governance and economics of food production, the sustainability of food production, the degree to which food is wasted, and the way in which food production affects the natural environment. In many countries, governments in the 20th century largely ceded responsibility for food production, marketing and distribution to industry-funded organizations that set standards for food production, processing, distribution and sale. The Sustainable Development Goals are reinstating a role for nation-states in food system governance with an emphasis on nutrition and bio-sensitive food systems (i.e., food systems that deliver nutritious food in harmony with natural ecosystems), human security systems (i.e., systems that protect the vital core of all human lives in ways that enhance human freedoms and human fulfillment), and

social protection systems (i.e., systems that protect and help those who are poor and vulnerable, such as children, women, older people, those living with disabilities, the displaced, the unemployed, and the sick). Yet there are still conflicts within these goals with respect to the environment and biodiversity conservation.

The production and distribution of food has become increasingly complex as our food systems have evolved from the distribution of seasonally available natural produce to the manufacture of a wide range of highly processed foods. With globalized food systems, few countries are self-sufficient in food supply, creating complex interdependencies, with some benefits to diversity on the plate, but also with increasing social, economic and political tensions.

Figure 3 | **Examples of Australian, Tanzanian and US households and where their food originates**

USA

117.5m households with an average of **2.6** people.
Of pet owners: **37%** own a **dog**
29% own a **cat**.

The **blue** area estimates the origin of American food.

Australia

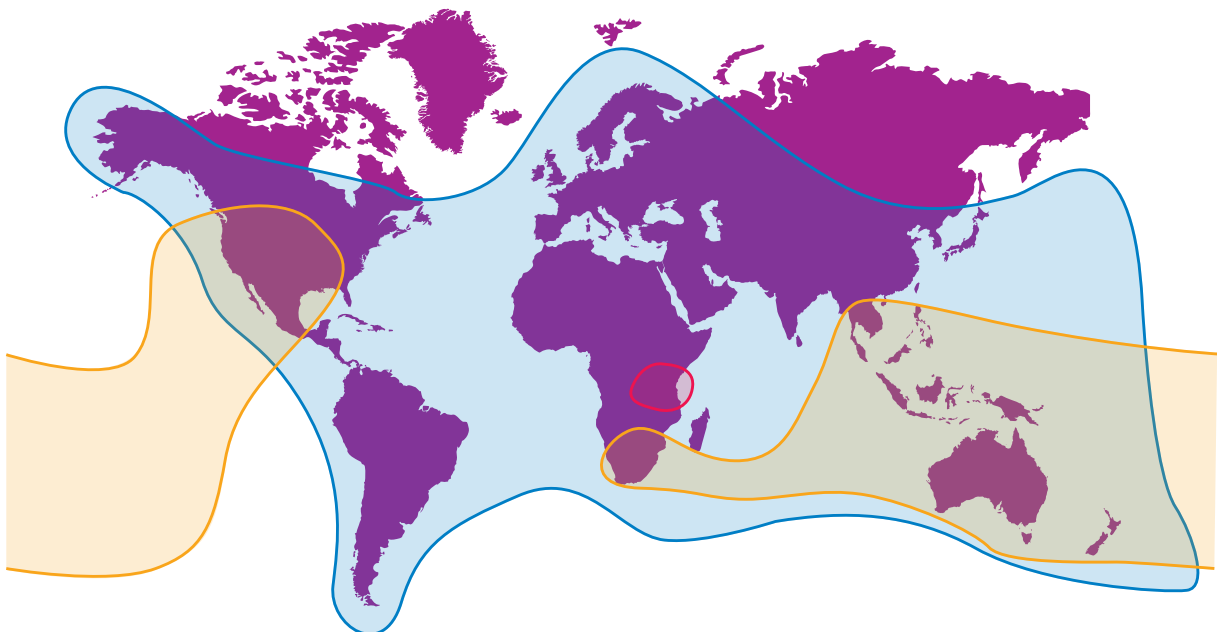
7.8m households with an average of **2.6** people.
Of pet owners: **39%** own a **dog**
29% own a **cat**.

The **yellow** area estimates the origin of Australian food.

Tanzania

9.16m households with an average of **4.9** people.
Of pet owners: **14%** own a **dog**
<1% own a **cat**.

The **pink** area estimates the origin of Tanzanian food.



Source: Household data compiled from Animal Health Alliance (2013), American Veterinary Medicine Association (2012), Australian Bureau of Statistics (2006), Knobel et al. (2008), UNFPA (2013), US Government (2009). Graphical representation of origin of food estimated by authors.

The farming of laying hens and broilers has grown in intensity as the popularity of poultry meat has risen worldwide.

Source: Mike Bloem



3. Building resilient and sustainable food systems

Sustainable food systems require a collective effort to tailor and integrate food production, processing, distribution, consumption and waste management to enhance environmental, economic and social health in harmony with agro-ecological systems.

There is no single, universally appropriate food system. Across the globe, food production and distribution continue to occur in myriad ways. There is no such as thing as global best practice, as all food systems can have unexpected and unintended consequences. These consequences need to be better documented and critically evaluated to help pave the way to more sustainable and environmentally supportive approaches. Hunting and gathering still exist in some parts of the world, and non-cultivated foods and the landscapes that produce them require greater attention. Such attention is critical if these landscapes are to maintain their capacity to renew themselves and the food sources they provide. At the same time, extensive or intensive production systems that harness science and technology may be the most appropriate means of making food available in most parts of the world. Full accounting of the comparative ecological costs of different systems is needed to identify best practice to inform effective nutrition policy. This should take into consideration a range of factors, including soil and water security, subsidies (e.g., fuel, fertilizer, pesticides, herbicides), and nutrition-sensitive value chains.

Currently few examples exist of truly sustainable food systems that can support the world's growing human population. Food underpins population growth, and the sustainability of the world's food systems in their present state depends on a slowing of the current rate at which the global population is growing. If such a deceleration is to occur, it will require the education and empowerment of women in particular, and the adoption of a range of family planning measures.

Nevertheless, there are examples of sustainable food systems in the making. These include agro-ecologically managed smallholder farms such as Latin America's *Campesino* and Zapotec agroforestry movements that increase yields, conserve soil, water, and biodiversity, and capture carbon to cool the planet. Kenya's Northern Rangeland Trust is another example where ecosystem services benefit communities through a balanced livestock wildlife-integrated livelihood system providing sustainable food, natural resources and tourism income. Urban farms from Havana to Bangkok are steadily increasing food production and improving the livelihoods of local communities. Community-supported agriculture groups

around the world are providing fresh, healthy food for members – and, at the same time, a living income for local family farmers. Hundreds of municipal Food Policy Councils and Food Hubs are implementing citizen-driven initiatives to keep the “food dollar” in the community, where it can be recycled up to five times, thereby creating jobs and stimulating local economic development.

Healthy land that can support healthy people requires sustained fertility and functionality of the soil as the basis for biomass production. Soil is the “foundation” for the ecosystem, and healthy soil ensures renewable water reserves and captures carbon. In the case of Europe, for instance, eight main threats to the quality of soil have been identified, including erosion; local and diffuse contamination; loss of organic matter; loss of biodiversity; compaction and other physical soil deterioration; salinization; floods and landslides; and sealing. These threats are endangering soil quality, and cause millions of euros of damage every year. They remain a continued source of concern, and require urgent attention.

Maintaining natural and agricultural biodiversity will help absorb the inevitable shocks that occur in the more industrialized food-producing systems, which are the main systems now serving the world's population. This involves, among other interventions, identifying genetic traits that endow resistance to changing environmental conditions and encouraging natural and sustainable methods of harvesting.

The world's future food systems will need to:

- Provide full socio-ecological accounting;
- Assess nutrient recycling;
- Minimize or eliminate all forms of tillage;
- Prevent over-grazing and over-cropping;
- Make systems equitable, sustainable (environmentally, socially and economically), and resilient to weather variability;
- Provide diets suitable to the life stages and cuisines of sub-populations;
- Be based on ecosystem, human and animal health needs dictating production levels using sustainable systems adapted to local agro-ecological zones; and
- Contribute to evidence- and rights-based policy-making on access to food for humans and animals (domestic as well as wild).

4. Three key food production challenges

To deliver sustainable food systems, three challenges need to be overcome. These are to:

- move from “commodity-based” to “gender- and nutrition-sensitive” value chains;
- improve food processing, packaging and distribution; and
- ensure food safety.

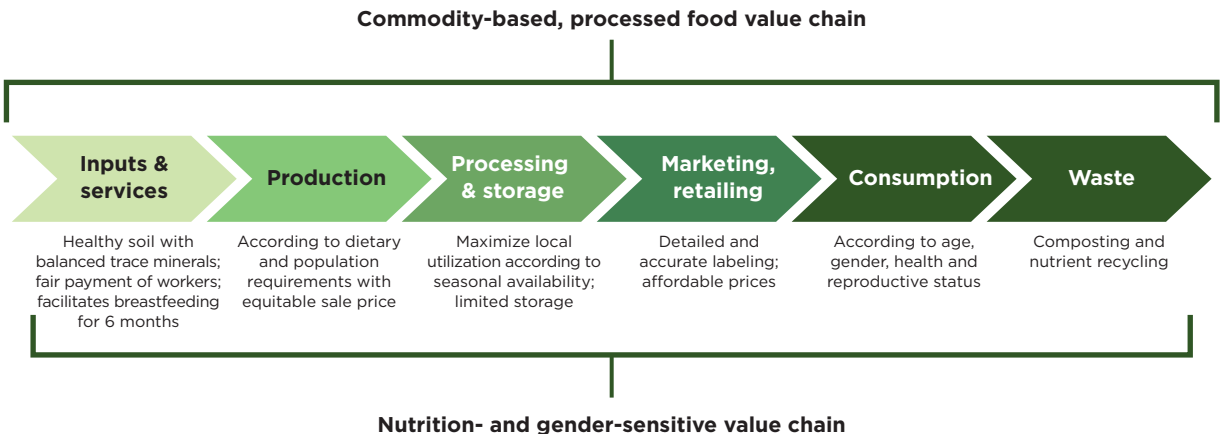
4.1. Maximizing the nutritional benefits of food production: gender- and nutrition-sensitive, sustainable and safe value chains

Despite increases in agricultural production during the past two decades, undernutrition in children has not diminished significantly in many developing countries, and obesity is now causing significant mortality and morbidity across the globe. High levels of undernutrition, lack of education among adult women (who frequently play a key role in agricultural production), and gender inequality have also shown a strong positive association with the prevalence of child undernutrition. Accessing sufficient calories is important, but calories alone are not sufficient to deliver optimal nutrition; the proper balance of micronutrients is also essential for both short- and long-term health. This has become clear as obesity and related health concerns are becoming significant issues in individuals and communities adopting Western diets worldwide.

4.2. Food processing: the freshness challenge

In almost all cases, fresh food is more nutritious than highly processed food.¹ In many parts of the world, household food preservation techniques such as salting and pickling traditionally enabled generation upon generation to store perishable food for consumption during lean periods. However, the processed products now manufactured and distributed by large corporations are reducing the diversity of many people’s diets. Processed food products are also transported and presented for sale in packaging such as plastics that consume significant natural resources and present major issues in terms of disposal or recycling and chemical leaching. Delivering sustainable, safe, nutritious, and fresh food to people across the globe is central to the concept of good nutrition in one world. In many parts of the world, meals prepared using locally sourced natural ingredients tend to have a higher nutritional value than their highly processed counterparts,² and sourcing produce locally supports small farmers and other traders in the food chain. In the future, food processing will promote food safety while also incorporating agents, such as phytase, that reduce anti-nutritional factors. Phytase inhibits the action of phytates (which occur naturally to varying levels in most plants) that bind minerals in the gut before they are absorbed and reduce the digestibility of starches, proteins, and fats. Phytase can be promoted by fermentation and soaking of grains and these processes could be incorporated into food processing to enhance phytases naturally occurring in the raw material as well as the addition of isolated phytases. Interestingly, phytase is already a common ingredient in feed produced for intensive chicken and pig production.

Figure 4 | Comparing “gender- and nutrition-sensitive” with “commodity-based, processed” food value chains



Source: Alders (2016).



Free-ranging livestock systems vary greatly and persist in many societies. These buffalo in Gujarat, India show the level of welfare and good health of these traditional free-ranging systems, which also contribute to healthy human diets.

Source: R Kock

4.3. Food packaging and distribution

One concept that would be of global benefit is the development of a simple rating system that can be used in the labeling of any food, to enable consumers to gauge the sustainability of the system that produced it and the healthiness of the food itself. At present there is no easy way for consumers, governments and donors to know any of this – although in many countries they can now choose their refrigerator, washing machine and car according to various detailed criteria. The anomaly is striking. It would be extremely beneficial to develop an algorithm that encompasses the main elements of sustainability – such as virtual water content, energy content, soil erosiveness index, and carbon emissions – and combines this with consumer health and ethical ratings.

To deliver fresh and safe food to our tables, value chains need to be shorter, and a greater proportion of the world's burgeoning population needs to start taking responsibility for producing at least some of its own food and for consuming diets that are optimal in terms of nutrient

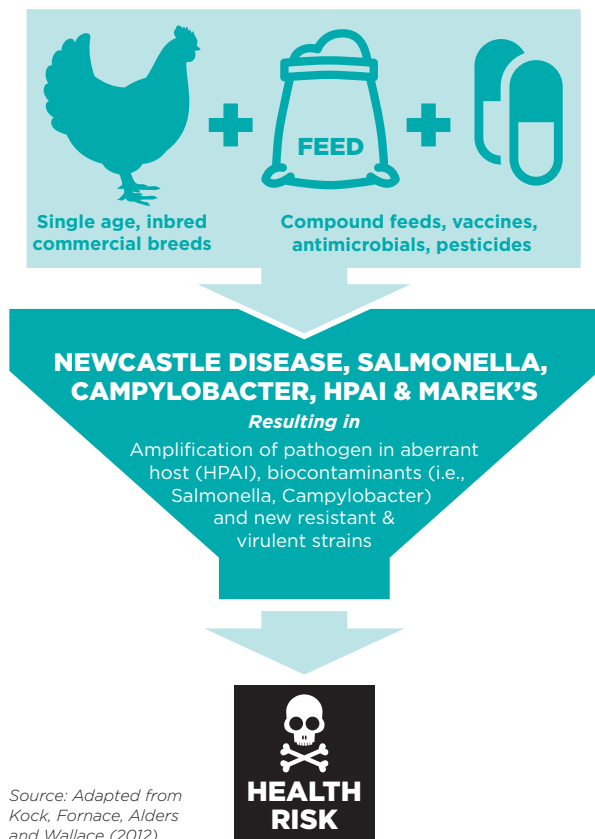
content and environmental impact. This involves, among other things, ensuring that nutrients are recycled. Although not practicable for inhabitants of cities, deserts and icy regions, for instance, it would generally be beneficial for as great a percentage of the world's food as possible to be both produced and consumed locally.

4.4. Food safety

Food safety is both vital and complex, and food safety standards usually touch all parts of the value chain. Much of the focus of food safety has hitherto been on pathogens and toxins. The intensification of livestock industries has contributed to the emergence and spread of zoonotic pathogens such as highly pathogenic avian influenza and campylobacteriosis, which are found in highly intensive commercial poultry production, for example. Increasing attention is also being given to the potential risks associated with modern processing and packaging procedures, the use of additives in processed foods and beverages, and the use of genetically modified foods.

Figure 5 | Components of intensive commercial poultry production and the unintended consequences observed since the 1990s

These consequences include the global spread of highly pathogenic avian influenza (HPAI), very virulent Newcastle disease (ND) and very virulent Marek's disease.



One popular way of preserving certain foods has for centuries been by using high concentrations of sugar. It is now clear that the inclusion of high levels of sugar in processed foods is a significant contributor to the obesogenic environment that is evident in many parts of the world today. Similarly, the traditional use of high levels of salt for the preservation of certain types of food is now recognized as being associated with elevated blood pressure and an increased likelihood of stroke and cardiovascular disease.

There is a need for new ways of preparing and preserving foods that make them attractive to consumers while at the same time reducing the levels of sugar and artificial additives that they contain. Refrigeration as a strategy for preserving food should also be revisited, as it does not always help reduce food wastage at the household level and can delay the disposal of food that has passed its use-by-date. Refrigeration has also

helped distance urban consumers from the seasons and the agricultural calendar, reduced diversity by encouraging the cultivation of cool-tolerant fruits and vegetables, increased energy usage, and driven up greenhouse gas emissions (in cases where hydrofluorocarbons are used as refrigerants).

Innovative methods of preserving food include:

- **Biopreservation/fermentation**
The use of non-toxic and beneficial microorganisms to ferment foods and beverages is an ancient form of biopreservation that was, and still is, used to produce foods such as beer, wine, vinegar, bread, yoghurt, and cheese. This technique can be applied in small and large food preservation ventures.
- **Solar drying**
Based on thermal energy storage materials, exposure to sunlight is quite effective for continuously drying agricultural and food products at a steady state in the temperature range of 40 °C to 60 °C.
- **Ultra-high pressure hydrostatic processing**
This approach eschews the use of chemical additives, and there is no contamination, or alteration to the taste of, the food. The bacteria in the food remain intact but are deactivated due to the pressure-induced dismantlement of their nucleic acid. With the exception of some fruits and vegetables, most foods can be pressurized without losing their structure.
- **Packaging innovations**
Modified atmosphere packaging (e.g., the insertion of a mixture of gases usually including oxygen, carbon dioxide and nitrogen) retards microbial spoilage and provides fresh and safe products.

Conducting effective risk assessments has its challenges, not least because the negative effect of a particular factor may not become apparent for many years. For example, it has been known for a long time that cooking food eliminates many pathogens. However, cooking will not necessarily eliminate all the pathogens that may be present in food. In the case of “mad cow” disease (bovine spongiform encephalopathy, or BSE), for example, agents such as prions are not inactivated by normal cooking, and their presence in the food chain can take years to become evident (e.g., the occurrence of a case of BSE in the United Kingdom in 2015, more than 25 years after rigorous controls were put in place following identification of the first cases in 1986).³

4.5. Food retailing

In a relatively short time, food retailing has become a massive global industry through which high-quality food finds its way to those who can pay for it, wherever they are in the world. With modern technology, even highly perishable goods such as fruit and vegetables can be transported vast distances. However, the existence of this technology, and of the accompanying infrastructure, has not delivered high-quality food to all communities. For example, in remote communities in Australia, food retailers generally offer highly processed foods, containing high amounts of salt and sugar, to younger generations who are no longer able to recognize and make use of wild foods (even in places these foods have not been decimated by feral animals or invasive weeds). Similarly in many cities, communities of low socioeconomic status also depend heavily on cheap highly processed foods. In both situations, “food deserts” are having long-term negative effects on society in relation to physical wellbeing, immunity, obesity, cognition, and mental status. The impact of poor nutrition on such communities contributes to the poverty cycle, with children failing to reach their genetic potential and the cumulative negative effects across generations leading to a vicious spiral of increasing health problems and diminishing productivity.

Our changing relationship with companion animals

At the same time, in more affluent societies, where dogs and cats are in some cases considered members of the family even though they make no contribution to hunting or pest control, the content of pet food has changed due to the anthropomorphic manner in which pets are viewed by their owners. The dietary requirements of companion animals are increasingly met by commercial pet foods of growing sophistication or by specially prepared home food. The irony whereby specially formulated diets are marketed to pet owners while human beings subsist on an inadequate, industrially produced diet is profound.

The new status of companion animals was highlighted in the aftermath of Hurricane Katrina in 2006, when many people refused to be evacuated unless they could take their pets with them. In response, the United States Congress passed the *Pets Evacuation and Transportation Standards (PETS) Act* with near-unanimous support. This act compels rescue agencies to save pets as well as people during natural disasters and marks a legal turning-point in our relationship with companion animals, as it made them members of society. A number of food companies now run parallel operations that cater for humans and their companion animals. This association is important both in terms of how

and to whom food is distributed and in terms of nutrition security and food safety. Currently, market forces tend to dictate food distribution systems. With increasing human population and decreasing land for food production, those tasked with ensuring good nutrition in urban and rural areas will take increased interest in how nutritious food is allocated geographically and within households.

5. Conclusions

To achieve sustainable food systems and adequately nourish 9 billion people by 2050, a paradigm shift is required that will involve action at every stage of the food value chain from the level of the soil to the plate. Such a shift would see sustainable, nutritious and safe food produced and delivered worldwide with minimal waste, with consumers being intimately reconnected to the environment and to the origins of the food that they consume.

Our personal view

**Robyn Alders,
Mike Nunn, Brigitte Bagnol,
Julian Cribb, Richard Kock &
Jonathan Rushton**

The authors of this chapter have a vision for the future whereby we all actively engage in designing our diets according to our individual needs in harmony with agro-ecological and political systems. Food has to regain center stage in our attention.

In this vision, people will seek out nutritious fresh food that meets our dietary requirements in an efficient and tasty manner. They will actively engage with food systems and nutrient cycles by having a kitchen garden or a herb pot on a window-sill, and chickens in the backyard. They will purchase food that has been grown sustainably by farmers who are treated ethically and paid a fair price for their labour, enabling them to tend their land and sustain natural ecosystems.

Research suggests that this approach is good not only for our planetary ecosystems but also for our internal systems, because it allows “good” microbes to flourish in our microbiome, leading to improved physical and mental wellbeing, increased capacity to make a positive contribution to society, and reduced dependence on medicines and healthcare systems.

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