13 Famine, Hunger, Society and Climate Change

Colin D. Butler
Faculty of Health, The University of Canberra, Australia, and National Centre for Epidemiology and Population Health, The Australian National University, Australia, and Benevolent Organisation for Development, Health & Insight (BODHI)

> And he gave it for his opinion that he that could make two ears of corn or two blades of grass to grow upon a spot of ground where only one grew before would deserve better of mankind and do more essential service to his country than the whole race of politicians put together.
>
> (Swift, 1729)

13.1 Introduction: Famine, Population Growth and the Cold War

In 1966, a famine was emerging in the chronically impoverished, caste-ridden northern Indian state of Bihar. Its ecological causes combined drought and flood with limited use of the then emerging technology to extract groundwater using tube wells (Brass, 1986).

India was an important Asian democracy. It was non-aligned during the Cold War, a prize ally for either of that undeclared conflict's main protagonists. Winning the hearts and minds of the people of the Third World had long been part of US policy, including through a programme established in the 1950s but christened as 'food for peace' in 1960 by John F. Kennedy, then campaigning for the presidency. On hearing of the Bihar famine, senior US state officials recommended emergency shipments of American grain. However, Kennedy's successor, President Lyndon Johnson, prevaricated, instead authorizing shipments only in increments, in exchange for evidence that India's family planning programme was being strengthened.

India is the birthplace of Amartya Sen, justly famous for his work on famine (Sen, 1981). In 1998, Sen was awarded the Nobel Prize in Economics, partly for his concept of economic 'entitlement'. India has a long familiarity with devastating famine, particularly in the 19th century, as described vividly, for example, by Mike Davis in his book, *Late Victorian Holocausts: El Niño Famines and the Making of the Third World* (Davis, 2001).

Across the Himalayas, China, the land that had long called itself the Middle Kingdom, had an even longer experience of recorded famine. Chinese bureaucrats are reported to have documented 1823 famines between 108 BCE and 1911 CE (Mallory, 1926). Famines did not end in China in 1911. In Communist China, between 1958 and 1961, Mao's catastrophic 'great leap forward' culminated in a famine kept secret at the time, killing at least 30 million people (Becker, 1996).

At the time that America was providing grain relief to India its officials may not even have known of the then recent Chinese famine. Lloyd Boyd Orr, founding director of the United Nation's Food and Agricultural Organization (FAO), was one of the rare Western visitors to go to China during the famine. Orr (then aged

 © CAB International 2014. *Climate Change and Global Health* (ed. C.D. Butler)

about 80), along with other dignitaries, including the President of the Royal Society, reportedly accepted at face value Chinese assurances of adequate food (Becker, 1996).

In 1949, Orr was awarded the Nobel Peace Prize for his pioneering work in nutrition. He was also intensely concerned with the links between food insecurity and possible conflict. As FAO Director, he had tried to promote world peace and food security through the establishment of a World Food Board and expanded agricultural productivity (Staples, 2003). Two decades later, the Nobel Prize committee reaffirmed their recognition of the link between food security and the avoidance of conflict by awarding its highest peace honour to the agricultural scientist, Norman Borlaug. Borlaug is the main parent of the 'Green Revolution', a term adopted because it was thought greater food supply could lower the attraction of Communism and thus avert the Red Revolution that many policy makers feared.

13.2 The Apparent Conquest of Famine by the Green Revolution

The Green Revolution relied on unparalleled international and interdisciplinary cooperation (Boyer *et al*., 2013). Achieved by the long-established techniques of selective plant breeding, it enabled far more food to be grown in a given area, provided there was adequate fertilizer and water. Its dependency on monocultures and fossil fuels, especially as the basic source of pesticides and nitrogen fertilizer, has been criticized by many activists, most notably Vandana Shiva (Shiva, 1991). In many countries, such industrialized agriculture favoured large farmers over small farmers, and helped to cement or intensify inequality. However, few if any scholars have credibly proposed how the widespread famines, perceived by many as otherwise plausible, could have been averted without the increased yield facilitated by the Green Revolution, the origins of which can be traced to the 1930s. It was well under way by the mid-1960s (a decade of intense concern about impending global food insecurity), though on a scale which at the time was little recognized.

There are many interlocking reasons for inequality and poverty, but most of these are social or 'natural' (e.g. geographical or environmental). Attributing poverty and inequality to the Green Revolution is simplistic, unless its meaning is widened to include the human institutions who apply and control these agricultural technologies.

In the following two decades, the Green Revolution was spectacularly successful in putting the global plough (food supplies) ahead of the stork (human numbers) (see Fig. 13.1). World hunger also declined, not only as a proportion but also even in absolute terms. A few famines occurred from 1970 to 2000 (including in Bangladesh in 1974 and Ethiopia in 1984), but their scale was modest compared to what had been feared and predicted.

In his 1970 Nobel Prize acceptance speech, Borlaug warned:

> The Green Revolution has won a temporary success in man's war against hunger and deprivation; it has given man a breathing space. If fully implemented, the revolution can provide sufficient food for sustenance during the next three decades. But the frightening power of human reproduction must also be curbed; otherwise the successes of The Green Revolution will be ephemeral only.
>
> (Tribe, 1994)

This warning was quickly forgotten. In 1984, US President Ronald Reagan became the first of a series of US presidents to declare explicitly that the importance of human population size had been overestimated (Butler, 2004). Since then, the plough has no longer been gaining on the stork. Although some food experts, including the former head of the World Food Programme, Josette Sheeran, have claimed that food production per person has continued to increase in recent decades and is now at a record high (Sheeran, 2011), the reality is less comforting. Already, more than one-third of the US maize crop is diverted to biofuels. While a fraction of its food value is recovered and fed to cattle as 'distiller's grain', this quantity of maize could feed millions of people if fed directly to them. If grain and soy lost from the human diet because of diversion to biofuel[1] is subtracted, the residual amount of grain and soy (and probably total food) per person is stable or declining (see Fig. 13.1). Compounding this is the problem of the increasing quantity of calories in food edible by humans that is diverted to feed livestock, including farmed fish. At the same time, the global population

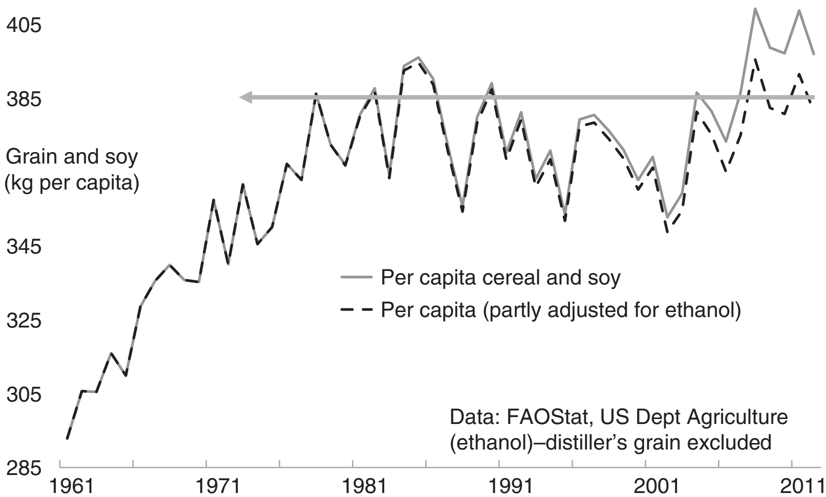

Fig. 13.1. Between 1960 and 1985, grain production increased far faster than population, due to the Green Revolution. Global hunger also declined substantially. Since 1985, increasing quantities of soy (not a grain, but a food that shares important similar properties, especially its ease of storage and shipping) have been grown, especially as feed. In more recent years, however, substantial soy and grain (especially maize) has been diverted from food, or feed, to fuel. Sufficient grain is still grown to alleviate hunger, were it distributed more equitably.

continues to rise by over 70 million per annum, an annual increment probably exceeding that in 1968, when global population increase peaked as a percentage.

The incidence of famine again appears to be increasing. Several famines have occurred recently in North Africa, including Kenya, Somalia, Sudan and Niger. The Islamist group, Al Shabaab, which exerts much control over modern Somalia, has worsened the human toll of the Somali famine greatly by tactics such as intimidating, kidnapping and killing famine relief workers (Maxwell *et al*., 2012). Yet, in nearby Somaliland, a quasi-independent breakaway nation, little, if any, famine occurred at all, even though it too has experienced severe drought. An Asian country, the Democratic People's Republic of Korea, has also experienced severe food insecurity and frank starvation since the late 1990s.

13.3 Inequality, Vegetarianism and Other Forms of Food Waste

It is true that a complete global sharing of food resources, with the total abandonment of feeding grain and other crops such as soy to livestock as feed, would have lessened world famine considerably without any Green Revolution, as was advocated in 1971 in the book, *Diet for a Small Planet* (Lappé and Collins, 1971). However, as with alternatives to the Green Revolution, I am unaware of scholars then or now who have viewed complete vegetarianism as a viable or total solution to world hunger. Vegetarian diets can be healthy for many people,[2] but are neither culturally preferred nor ecologically possible in many places. Nor, probably, are they physiologically adequate for many populations, including those forced by ecological factors to rely largely on livestock for food consumption. Genetic variations such as haemochromatosis are advantageous for people with limited iron intake (Naugler, 2008). Those lacking this or similar genes may be at a disadvantage if forced to be vegetarian.

Arguments for a completely equal distribution of global food resources are also problematic. While excessive inequality cannot be tolerated indefinitely in either human society or many animal groups, all human and most animal groups are, none the less, characterized by many forms of inequality, such as of power, experience, strength and ability. A large reduction of human inequality, on a scale sufficient to generate adequate food for all, may be partly achievable, not least as being overfed is harmful to health and sustainability. But such large-scale redistribution also seems unrealistic, or even utopian.

However, much food is lost from human ingestion due to pests and poor storage. The custom of eating offal has vanished among most affluent populations, leading to a waste of nutrients. In rich countries, enormous quantities of edible food are thrown out of supermarkets, restaurants and people's homes (Parfitt *et al*., 2010).

13.4 Famines Have Ecological *and* Social Causes

Opinions vary concerning the causality of famine. At one extreme are experts influenced by Sen, who argue that the dominant cause of all or most recent famines is social (Patel, 2012). Others are more nuanced, conceptualizing famine as 'ecosocial'. Mike Davis recounts how more powerful populations, whether in India, China or parts of Africa, have thrived while others have starved. India's colonial ruler regularly appropriated Indian-grown food for consumption in Britain, even during severe Indian famines.[3] However, Davis implicitly recognizes an ecoclimatic contribution by including the cyclic climatic event, El Niño, in his book's subtitle (Davis, 2001).

Sen's seminal work on 'effective' entitlement, defined as the capacity to gain food by cultivation or purchase, was shaped by his childhood in Calcutta (today Kolkata). Sen witnessed the catastrophe during World War II now known as the Bengal Famine, which claimed 2–3 million lives (Sen, 1981). He showed that harvests in the year of the greatest death toll (1942) exceeded that of 1941. However, as in the famines described by Davis, I argue that an interaction between ecoclimatic and social factors was at play. If a bumper harvest had occurred in Bengal in 1941, then no famine would likely have occurred in either that year or the one following.

Others support the view that most famines have mixed causation. In 1926, Mallory wrote: 'There are some famines that are due almost certainly to "natural" causes (i.e. drought, locusts, plant disease), and there are scarcely any to which natural phenomena do not contribute' (Mallory, 1926). Brass, discussing the Bihari famine of 1966–1967, describes proximate and remote causes, both ecological *and* social (Brass, 1986).

Even the prolonged famine in the Democratic People's Republic of Korea has ecological as well as social causes. While the hermit kingdom's cruel and repressive regime has numerous policies which repel foreign aid and assistance, a series of poor harvests, some associated with torrential rains and others with unusually high temperatures, have also contributed.

However, the lesser-known famine in North Vietnam during 1944–1945, which killed up to 2 million people, had little, if any, contributing climatic cause. Instead, the direct reason for this was the requisitioning of locally grown food by the occupying Japanese army. The role of Vietnam's colonial master, France, has also been blamed. Earlier in the 20th century, the Ukrainian famine may also illustrate an exclusively socially caused event, resulting from the deliberate suppression of the Ukrainian people by the policies of Stalinist Russia (see Fig. 13.2).

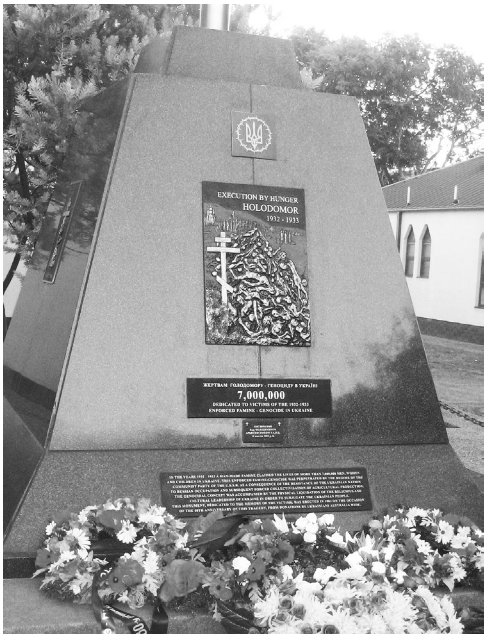

Fig. 13.2. The plaque reads '7,000,000. Dedicated to victims of the 1932–1933 enforced famine – genocide in Ukraine', Canberra, ACT, Australia (photo C.D. Butler).

At a finer scale, the social and environmental factors that can generate abundant locally available food do not guarantee either local ingestion or good utilization of ingested nutrients. In the agriculturally rich, populous Indian state of Uttar Pradesh, up to 60% of children are chronically undernourished (Black *et al.*, 2008), and thus stunted physically and mentally (Dillingham and Guerrant, 2004). This dismal loss of human potential arises through a combination of being underfed on a background of poor hygiene, dirty water and limited sanitation. This leads to excess disease, including diarrhoea, fevers and malabsorption, including from parasites (see Fig. 13.3). Not only the ingestion of food but also access to toilets and clean water requires 'entitlement'.

Furthermore, even if a population has sufficient entitlement to obtain and ingest food of adequate quality, quantity and variety, adequate nutrition for less favoured members of that group is not automatic. Many groups discriminate against females, or preferentially feed earners rather than dependents, even if dependents are ill.

Crucially, discrimination against less powerful individuals, and even entire populations, is particularly likely if food supplies are stressed by environmental factors such as drought, flooding or, as in parts of the Sudan, fear of random attack by bombers operated by the national government. In parts of Africa, physical insecurity has favoured the planting of the less nutritious root crop, cassava, which remains edible below ground for up to 36 months and is easier to hide from marauding enemies than, for example, maize (Rosenthal and Ort, 2011).

In summary, attributing famine *solely* to social causes is overly simplistic. Even if humans were as egalitarian and cooperative as ants, equal ingestion of food and sufficient nutrients to avoid famine is not always possible during times of extreme generalized food scarcity. But no human society has been completely egalitarian; young children, the poor and the elderly are at special risk. If food scarcity occurs because of either social or environmental causes, then intensified nutritional inequality is very likely. The rationing of food and other forms of entitlement which occurred during World War II in the UK is an exception.

There is evidence that Australian Aborigines maintained low population numbers in

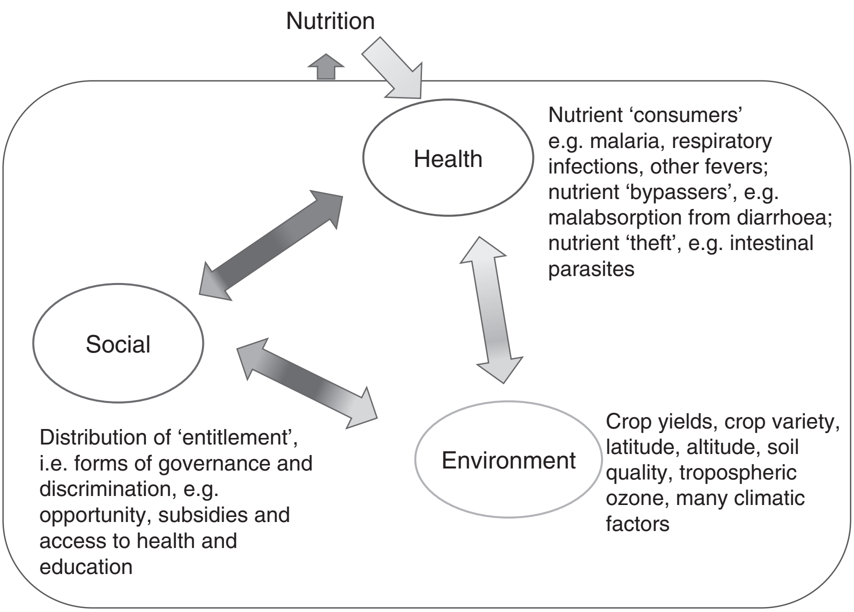

Fig. 13.3. Population nutrition can be conceptualized as arising from the interaction of social, health and environmental factors, in a complex system. Many relationships are bidirectional. For example, poor population health status can impair social function (e.g. by impaired education).

part so they could avoid famine or other forms of undue hardship even if food supplies became scarce (Butler, 2012). The Australian climate, dominated by the El Niño Southern Oscillation that swings from the drought of El Niño to the floods of La Niña, is very variable in Eastern Australia.

This section has argued that, more often than not, famines are caused by an interaction of ecoclimatic causes (e.g. drought, flood and plant diseases such as potato blight) and social causes (such as poor governance, conflict and discrimination against minorities and vulnerable individuals). This interplay between eco-climatic and political events is a characteristic of tertiary events, as outlined elsewhere in this book. Famines and large-scale food insecurity, even without frank starvation, also have the potential to harm health on a far larger scale than any of the primary or secondary effects discussed in previous sections of this book.

The next part of this chapter outlines the evidence of an effect of climate change on crop growth. It is plausible that, as the other tertiary effects of climate change worsen (i.e. large-scale population dislocation and conflict), increasingly governance could fail, also contributing to famine.

13.5 Rising Food Prices and Climate Change

For centuries, the long-term trend of food prices has been in decline (Naylor and Falcon, 2010). Since 1961, the FAO has calculated an index of food prices (see Fig. 13.4). The increase in this index in 2008 surprised many observers, even though it was consistent with the warnings given by Borlaug and the World Scientist's Warning to Humanity.

The most plausible proximate cause of the food price increase in 2008 is that year's rise in energy prices, especially oil, which reached over US$140/barrel (Piesse and Thirtle, 2009). Higher energy prices also increased the price of fertilizer. That price spike was not long sustained, due to the global financial crisis and recession. However, in December 2010, the global price index of food approached the 2008 peak and remained

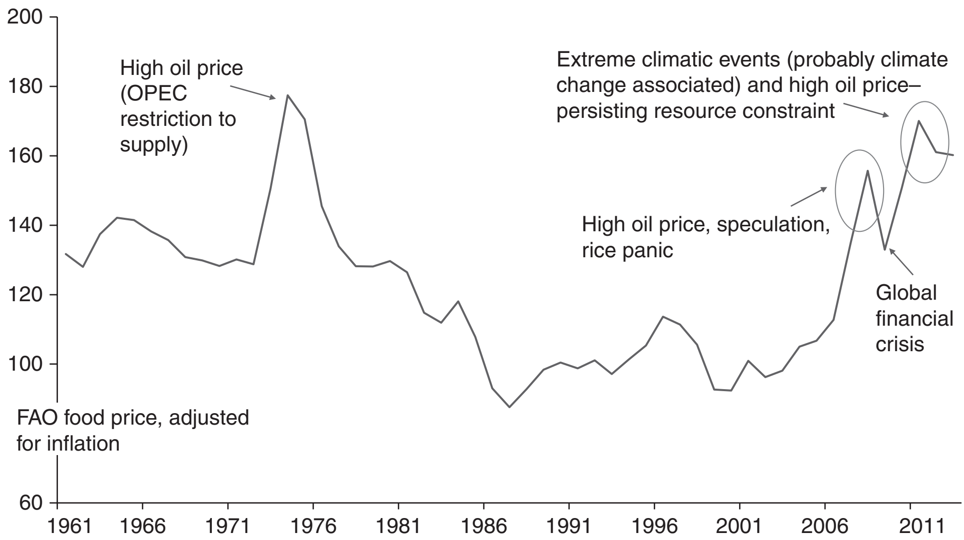

Fig. 13.4. FAO food nominal price index, 1961 to October 2013. Since 2005, there have been two pronounced spikes in food prices. The first one (2008) was driven by high oil prices, speculation and restrictions on rice exports. However, extreme weather events, themselves possibly influenced by climate change, are likely causes of the second rise, which started at the end of 2010. Prices declined slightly in mid-2013, but are still historically high. The diversion of crops to biofuels is a background factor, but cannot fully explain either rise.

unusually high until mid-2013. Yet, the price of energy was higher at its 2008 peak.

To date, few published studies have analysed the cause for this second price rise. Two factors seem important in addition to fairly high energy prices. One is the apparently relentless rise in the fraction of global food crops used for biofuels, which itself is largely in response to the growing scarcity of easily recoverable crude oil, essential for transport using current technology.

But, the second reason may be a non-linear response in the price of food to extreme climatic events. The most notable of these were the Russian and Ukrainian heatwave of 2010 and the Pakistani flood in the same year. The Russian heatwave was especially significant to the global food price because it affected the traditional 'bread bowl' of the former Soviet Union. It led to a 66% increase in the global price of wheat within 2 months and a lesser rise in other grain prices (Naylor and Falcon, 2010). The floods in Pakistan did not exert a very large death toll, but displaced over 20 million people, some of them for months. Both events reduced crop production in 2010, sufficiently to contribute to a decline in per capita global grain production (see Table 13.1). Previously, the extraordinary European heatwave of 2003 also lowered crop yields. However, this event did not appreciably affect global food prices. The USA then experienced a severe drought and heatwave in 2011 and 2012. Although the dryness has apparently occurred at other times in the last millennium (Boyer *et al.*, 2013), its conjunction with such heat may be unprecedented, and thus attributable in part to elevated greenhouse gas levels.

There is debate as to whether climate change contributed to the Russian heatwave. However, there is increasing support for the proposition that the burden of evidence concerning the contribution of climate changes to such events should be reversed. That is, some climate scientists are now arguing that climate change should be accepted as a contributor to these extreme events until proved otherwise (Trenberth, 2011).

The recent Somali famine may also be related causally to climate change. In the past three decades, the Indian Ocean has warmed especially fast, in association with increased precipitation over the tropical Indian Ocean. Williams and Funk claim that, since 1980, this has suppressed convection over tropical eastern Africa, decreasing precipitation during the 'long rains' season of March–June. Unfortunately, their attempts to alert Somali authorities to the likelihood of famine were unsuccessful, but may have benefitted other, better-governed parts of the Horn of Africa, including Somaliland and Ethiopia (Funk, 2011; Williams and Funk, 2011).

Crop production is vulnerable to many factors associated with climate change, apart from extreme weather events such as those listed in Table 13.2. Some regions and crops are expected to benefit, especially in high latitudes. Like humans, plants have evolved to cope best in a given temperature range. For example, the increased yield for potatoes in Scotland has been attributed to warmer temperatures there (Gregory and Marshall, 2012).

Overall, evidence suggests that the effects of climate change on land-based agriculture are increasingly adverse, especially for wheat and maize, but not (yet) for rice and soy (Lobell *et al.*, 2011). Nocturnal warming in tropical areas has been found to harm the yields of both wheat (Prasad *et al.*, 2008) and rice (Peng *et al.*, 2004), and these adverse effects seem likely to be increasingly influential. None the less, the magnitude of detected decline in land-based agricultural production due to increasing temperatures and changes in rainfall is small compared to increased harvests due to improved farming

Table 13.1. Two particularly extreme weather events occurred in 2010, the heatwave in Russia and Ukraine and the Pakistani floods. In 2009, Russia and Ukraine grew 12.1% of the global wheat production, but in 2010, this proportion fell to 9% (of a smaller total). Paddy rice production declined markedly in Pakistan in 2010, but this had only a small impact on total global production. In 2009, Pakistan grew only 1.5% of the world's paddy rice.

	Wheat				Paddy rice		
	Russia	Ukraine	Global	Per capita	Pakistan	Global	Per capita
2010 (as per cent of 2009)	67	81	95	94	70	98	97

Table 13.2. Since 2003, several extreme weather events have occurred which have reduced crop production. Some of these have been linked to climate change. At present, there is no comprehensive data set of 'extreme agricultural events', and the apparent trend in the severity of these events may partly reflect recall and reporting biases. Nevertheless, other factors (e.g. declining crop yield growth, falling soil fertility, competition from feed and biofuels and ongoing population growth) mean that any reduction in crop growth due to extreme weather events is increasingly likely to have an adverse effect on global food prices, per capita global food production and, thus, on global health.

Event	Year	Location	CC attribution?	Significant crop production effect?
Heatwave	2003	Europe	4/5	Yes
Fires and heat	2009	Australia	4/5	Yes
Typhoon	2009	Taiwan	2/5	Yes
Heatwave	2010	Russia and Ukraine	3/5	Yes (significant global price rise at time)
Flood	2010	Pakistan	2/5	Yes
Flood	2011	Thailand	0/5	Likely (no FAO data yet)
Drought	2011	North-east Africa	3/5	Yes (famine)
Heat and drought	2011–2012	USA	4/5	Likely (no FAO data yet), significant price rise in maize, soy
Drought	2012	Niger	?	Yes (famine)

knowledge and technology. It is also trivial compared to the amount of food fed to livestock, used for biofuels, consumed beyond baseline needs by the overnourished and wasted in other ways (Foley *et al.*, 2011).

13.6 Modelling Climate Change and Famine

The modelling of past and future agroclimatic effects is a formidable challenge, even without considering their health impacts. Existing agroclimate models are excessively simple and biased toward the optimistic (Butler, 2010; Gornall *et al.*, 2010). The decline detected in food production ascribed to climate change is already likely to be understated, and that of future climate change even more so.

Concern over future climate change and crops is amplified by increasing doubt over the benefits and strength of the carbon fertilization effect (CFE), especially for C_4 plants such as maize and sugar (Long *et al.*, 2006). In response, agroclimatic models increasingly incorporate positive and more neutral CFE effects. However, the CFE may also enhance the growth of pests (Ziska *et al.*, 2009) and damage some crops, including cassava, a staple for about 750 million mostly poor people (Gleadow *et al.*, 2009). These effects to date are not incorporated into models.

Current agroclimatic models also poorly incorporate increased extremes, including rainfall intensity, sea level rise, saline intrusion, glacial melting and the possibilities of monsoon weakening and intensification of the El Niño Southern Oscillation and other ocean currents and atmospheric oscillations. They also omit the effect of climate change on mycotoxins, and on crop and animal diseases (Butler, 2010).

The capacity of ingested food to provide adequate nutrition is influenced by other factors, such as the level of physical activity (not just paid work, but unpaid labour such as hauling water, sometimes over hilly terrain) and by states of health and disease that lower appetite (Mangili *et al.*, 2006), nutrient absorption and metabolic rates.

13.7 Fisheries

Climate change is also predicted to have complex effects on fisheries, including by changing the pattern of ocean currents, thus redistributing marine productivity, especially to higher latitudes. A declining trend in the global phytoplankton concentration since 1899, in eight out of ten ocean regions, has been linked with warming sea surface temperatures. Increasing ocean acidity and climate change associated deoxygenated zones will also harm future marine productivity. Furthermore, ocean acidification associated with increased carbon dioxide concentrations interferes with the development of a wide range of aquatic species. It is already harming coral reef systems and further stressing fish stocks already in decline.

13.8 Solutions

Increased famines, consequent in part to climate change, appear likely. If left unaddressed, climate change threatens increasingly profound negative effects on food security, and hence on health and nutrition. Rising food prices stimulate social unrest and can contribute to the overthrow of governments. Conflict can occur easily due to the scarcity of raw materials, including food and fertile soil. While climate change requires adaptation, mitigation is an even more important priority.

Much can be done to reduce the enormous waste of food, whether preharvest (such as losses on the field), postharvest (e.g. eaten by rodents) or postprocessing (e.g. thrown out from supermarkets or wasted after purchase). Food fed to people suffering from chronic diarrhoea can be utilized better if their illnesses can be reduced by better health care, adequate sanitation and clean water. Overfed people, especially if consuming animal products raised on grain and soy, can and should reduce their consumption of these products.

There are calls for a new agricultural revolution, to be fostered by further investment. While this might help at the margins, too much hope may already be invested in this strategy, though much could be done to bring the Green Revolution to Africa (Ejeta, 2010). The World Bank in 2013 warned that if the average temperature rose by four degrees, then the most alarming effect was likely to be on food production (World Bank, 2013). However, food production is still likely to be affected greatly by climate change, even if global temperature increase can be held at a level far lower than this.

It is important that the determinants of fertility in low-income populations are altered in ways that will increase child survival and the effective demand for education and lower population growth. The final chapter of this book will discuss other general principles of solution. Adapting crops to cope with drought, flood and inundation from the sea is feasible to a point, but only to thresholds which may soon be exceeded. A holistic, global approach is required, which integrates society, education, health care, equity and technology.

Notes

[1] Not only from maize but also from other important crops such as sugarcane and palm oil.

[2] If supplemented with eggs, dairy products or at least vitamin B12 supplements.

[3] On the other hand, the rapid spread of the Indian rail network – a then recent British invention – did much to relieve Indian famine.

References

Becker, J. (1996) *Hungry Ghosts: China's Secret Famine*. Henry Holt, New York.

Black, R.E., Allen, L.H., Bhutta, Z.A., Caulfield, L.E., de Onis, M., Ezzati, M., *et al.* (2008) Maternal and child undernutrition: global and regional exposures and health consequences. *The Lancet* 371, 243–260.

Boyer, J.S., Byrne, P., Cassman, K.G., Cooper, M., Delmer, D., Greene, T., *et al.* (2013) The U.S. drought of 2012 in perspective: a call to action. *Global Food Security* 2, 139–143.

Brass, P.R. (1986) The political uses of crisis: the Bihar famine of 1966–1967. *The Journal of Asian Studies* 45, 245–267.
Butler, C.D. (2004) Human carrying capacity and human health. *Public Library of Science Medicine* 1, 192–194.
Butler, C.D. (2010) Climate change, crop yields, and the future. *SCN News* 38, 18–25.
Butler, C.D. (2012) Population trends and the environment. In: Friis, R.H. (ed.) *Praeger Handbook of Environmental Health*. Praegar, Westport, Connecticut, pp. 215–231.
Davis, M. (2001) *Late Victorian Holocausts: El Niño Famines and the Making of the Third World*. Verso, London.
Dillingham, R. and Guerrant, R.L. (2004) Childhood stunting: measuring and stemming the staggering costs of inadequate water and sanitation. *The Lancet* 363, 94–95.
Ejeta, G. (2010) African Green Revolution needn't be a mirage. *Science* 327, 831–832.
Foley, J.A., Ramankutty, N., Brauman, K.A., Cassidy, E.S., Gerber, J.S., Johnston, M., *et al.* (2011) Solutions for a cultivated planet. *Nature* 337, 337–342.
Funk, C. (2011) We thought trouble was coming. *Nature* 476, 7.
Gleadow, R.M., Evans, J.R., McCaffery, S. and Cavagnaro, T.R. (2009) Growth and nutritive value of cassava (*Manihot esculenta Cranz.*) are reduced when grown in elevated CO_2. *Plant Biology* 11, 76–82.
Gornall, J., Betts, R., Burke, E., Clark, R., Camp, J., Willett, K., *et al.* (2010) Implications of climate change for agricultural productivity in the early twenty-first century. *Philosophical Transactions of the Royal Society B* 365, 2973–2989.
Gregory, P.J. and Marshall, B. (2012) Attribution of climate change: a methodology to estimate the potential contribution to increases in potato yield in Scotland since 1960. *Global Change Biology* 18, 1372–1388.
Lappé, F.M. and Collins, J. (1971) *Diet for a Small Planet*. Institute for Food and Development Policy, San Francisco, California.
Lobell, D.B., Schlenker, W. and Costa-Roberts, J. (2011) Climate trends and global crop production since 1980. *Science* 333, 616–620
Long, S.P., Ainsworth, E.A., Leakey, A.D.B., Nösberger, J. and Ort, D.R. (2006) Food for thought: lower-than-expected crop yield stimulation with rising CO_2 concentrations. *Science* 312, 1918–1921.
Mallory, W.H. (1926) *China: Land of Famine*. American Geographical Society, New York.
Mangili, A., Murman, D.H., Zampini, A.M., Wanke, C.A. and Mayer, K.H. (2006) Nutrition and HIV infection: review of weight loss and wasting in the era of highly antiretroviral therapy from the nutrition for healthy living cohort. *Clinical Infectious Diseases* 42, 836–842.
Maxwell, D., Haan, N., Gelsdorf, K. and Dawe, D. (2012) The 2011–12 famine in Somalia: introduction to the special edition. *Global Food Security* 1, 1–4.
Naugler, C. (2008) Hemochromatosis: a Neolithic adaptation to cereal grain diets. *Medical Hypotheses* 70, 691–692.
Naylor, R.L. and Falcon, W.P. (2010) Food security in an era of economic volatility. *Population and Development Review* 36, 693–723.
Parfitt, J., Barthel, M. and Macnaughton, S. (2010) Food waste within food supply chains: quantification and potential for change to 2050. *Philosophical Transactions of the Royal Society B: Biological Sciences* 365, 3065–3081.
Patel, R.C. (2012) Food sovereignty: power, gender, and the right to food. *PLoS Medicine* 9, e1001223.
Peng, S., Huang, J., Sheehy, J.E., Laza, R.C., Visperas, R., Zhong, X., *et al.* (2004) Rice yields decline with higher night temperature from global warming. *Proceedings of the National Academy of Sciences* 101, 9971–9975.
Piesse, J. and Thirtle, C. (2009) Three bubbles and a panic: an explanatory review of recent food commodity price events. *Food Policy* 34, 119–129.
Prasad, P., Pisipati, S., Ristic, Z., Bukovnik, U. and Fritz, A. (2008) Impact of night-time temperature on physiology and growth of spring wheat. *Crop Sciences* 48, 2372–2380.
Rosenthal, D.M. and Ort, D.R. (2011) Examining cassava's potential to enhance food security under climate change. *Tropical Plant Biology* 5, 30–38.
Sen, A.K. (1981) *Poverty and Famines: An Essay on Entitlement and Deprivation*. Clarendon Press, Oxford, New Delhi.
Sheeran, J. (2011) Preventing hunger: sustainability not aid. *Nature* 479, 469–470.
Shiva, V. (1991) *The Violence of the Green Revolution. Third World Agriculture, Ecology and Politics*. Third World Network and with ZED Books, Penang and London.

Staples, A.L.S. (2003) To win the peace: the Food and Agriculture Organization, Sir John Boyd Orr, and the World Food Board proposals. *Peace and Change* 28, 495–523.

Swift, J. (1729) A Modest Proposal. For Preventing the Children of Poor People in Ireland from Being a Burden to their Parents or Country, and for Making Them Beneficial to the Public (http://art-bin.com/art/omodest.html#hit, accessed 16 March 2014).

Trenberth, K.E. (2011) Attribution of climate variations and trends to human influences and natural variability. *WIREs Climate Change* 2, 925–930.

Tribe, D. (1994) *Feeding and Greening the World*. CAB International in association with the Crawford Fund for International Agricultural Research, Wallingford, UK.

Williams, A.P. and Funk, C.A. (2011) Westward extension of the warm pool leads to a westward extension of the Walker circulation, drying eastern Africa. *Climate Dynamics* 37(11–12), 2417–2435.

World Bank (2013) *Turn Down the Heat: Why a 4 Degree Celsius Warmer World Must be Avoided*. World Bank, Washington, DC.

Ziska, L.H., Epstein, P.R. and Schlesinger, W.H. (2009) Rising CO_2, climate change, and public health: exploring the links to plant biology. *Environmental Health Perspectives* 117, 155–158.