Julian Cribb & Associates Discussion Paper

The coming Famine

Constraints to global food production in an overpopulated, affluent and resource-scarce world: the scientific challenge of the era.

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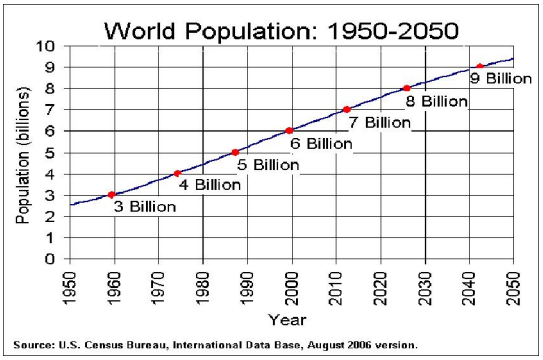


Barring nuclear wars, pandemics and cosmic accidents, there will be about 9.3 billion people living in the world of 2050 - but they will eat as much food as 13 billion people at today's nutritional levels.

The critical issue is whether such a harvest can be sustained.

Due to strong economic development, hundreds of millions of people can afford diets far richer in protein – in the cases of China and India, three to five times richer.

	Cereals (million tonnes)			Other crops (million tonnes)			Animal products (million tonnes)		
Year	1989	2025	2050	1989	2025	2050	1989	2025	2050
Develop-ing	940	1882	2419	1870	3950	5502	307	903	1405
Develop-ed	754	952	961	1110	1298	1262	565	666	660
World	**1694**	**2834**	**3380**	**2980**	**5248**	**6764**	**872**	**1569**	**2065**

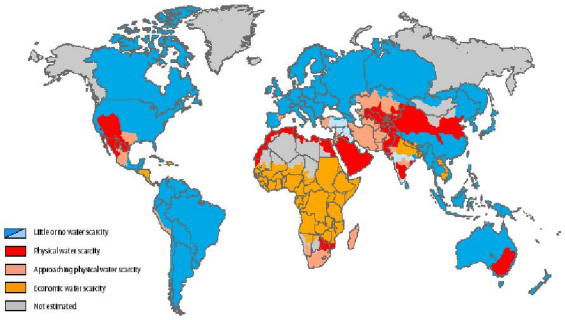
To meet such a demand, global food output must rise by 110 per cent in the coming 40 years, says the UN Environment Program. According to FAO and IFPRI, such a goal is technically feasible – provided most countries have advanced farming systems.

However key indicators affecting global food security now point downhill:

- surface water availability to agriculture is contracting due to city demand
- groundwater is in decline everywhere
- the arable land area is shrinking
- soil loss is increasing
- applied nutrients are far exceeded by losses
- agricultural research is in decline worldwide
- marine harvests are dwindling
- biofuels are replacing food crops

- half the world may face regular drought by 2050.

In this list of constraints, the thing that stands out is that only one is even somewhat uncertain – the scale of impact of climate change. The other trends are real, well-documented and predictable.



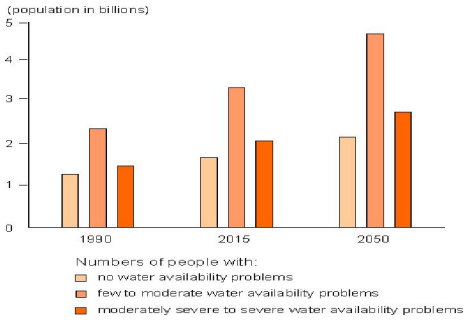
Water demand

For the first time in history, urban demand for water is outpacing farm demand, as city users outbid irrigators. By 2050 cities will consume half the world's fresh water – reducing that available for food production by a third.

Groundwater

Worldwide, groundwater is running out at an alarming rate, especially in regions using it to grow food. Examples include:

- China: water tables falling by >3 metres /yr
- India: 26 million wells = 200 cu kms/year, levels falling by 2-3 metres/year
- USA: 70 cu kms/year – levels fallen by 100-200m in Arizona
- Libya: "Great Man-Made River" already falling
- Australia: groundwater levels falling / water is 'double allocated'.

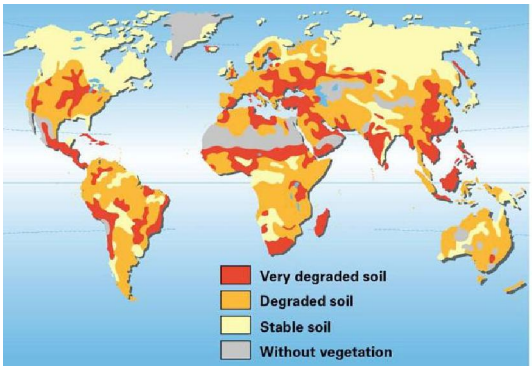


Water crisis

By 2050, 7 billion out of 9 billion people will face chronic-to-critical water shortages. (IWMI)

IFPRI research suggests that by 2025, water scarcity may inflict an annual loss of 350 million tonnes of food – roughly equivalent to losing today's global rice harvest or the entire US grain crop.

The challenge for the coming generation of farmers is to double food production using only two thirds of the currently available water. This implies a 200 per cent gain in water use efficiency, across all irrigation crops in every country in the world or else a massive switch to rainfed agriculture.

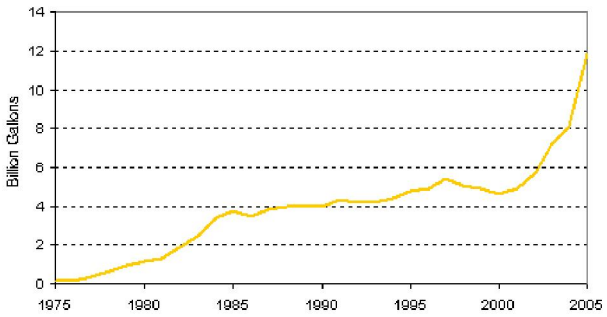


Soil loss

Around 1.2 billion ha or 10% of the world's arable area is affected by serious degradation, of which 300 m ha is now unfarmable. There is a continuing loss of about 5-10 million hectares a year. Eighty per cent of the remaining arable area is degraded to some degree.

While not seen by experts as a constraint to expanding *global* food production – as there are still forests left to fell in some regions – soil loss is a real constraint in India, Africa, the Middle East and parts of Asia. It is expected to worsen under climate change.

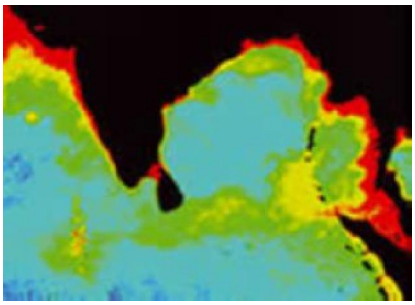
While the official consensus still holds that soil loss *alone* will not prevent a doubling in world food supplies, *coupled* with land, water and nutrient deficits and climate volatility it may have a considerable impact.



Biofuels

A recent, unheralded development has been a shift to the production of biofuels, both in the developed and developing world. Global ethanol production is forecast to reach 1 per cent of world oil consumption by 2010. Biofuels compete with food crops for land, water, energy, labour and nutrients and add to land degradation. Biofuels alone are expected to add around $40 a week to the average Australian household grocery bill.

By 2020, it is estimated, humanity will be burning around 400 million tonnes of grain – equal to the entire world rice harvest. This will placed pressure on food prices.



Marine crisis

Three quarters of world fisheries are fully or over-exploited, while demand for seafood continues to rise unsustainably (UNEP). By one estimate two thirds of marine fisheries will be in collapse by the 2020s and all of them by the 2040s.

One response has been increased aquaculture. However large areas of coastal seas and lakes are becoming unfit for aquaculture due to sediment, nutrient and chemical contamination from the land. Coral reefs supporting >500 million people and ocean harvests are being damaged by what is done on land as well as sea.

Ocean acidification from CO_2 fallout is also likely to impact marine primary productivity by destroying corals and calcareous algae which make up a third of ocean life. As aquatic protein supplies diminish, pressure rises for land-based agriculture to produce more meat (and feedgrains).

	1959/60	1989/90	2020
Region / Nutrient	(million tonnes of applied nutrients)		
Developed countries	24.7	81.3	86.4
Developing countries	2.7	62.3	121.6
World total	27.4	143.6	208.0
Nitrogen	9.5	79.2	115.3
Phosphate	9.7	37.5	56.0
Potash	8.1	26.9	36.7

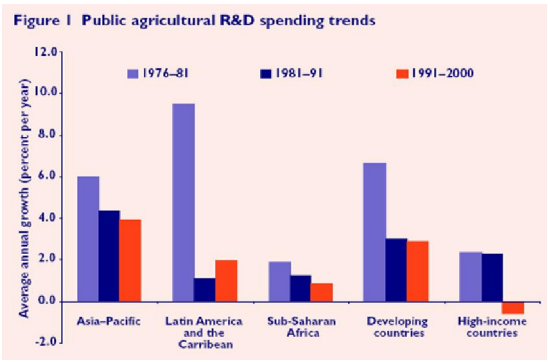
Nutrients

FAO rates global fertiliser supplies “ample” at around 150 million tonnes a year and says short-term demand growth of 1-2 per cent a year is within the world’s capacity to supply. However USDA and others note the world may be losing 1.1 *billion* tonnes of elemental nutrients a year, chiefly due to soil erosion. Applied fertilisers may thus replace only about 15% of total nutrients lost.

It is estimated up to half of all nutrients applied on farm are lost in runoff, leaching or erosion. Furthermore up to half the nutrients produced on farm are lost in handling & processing.

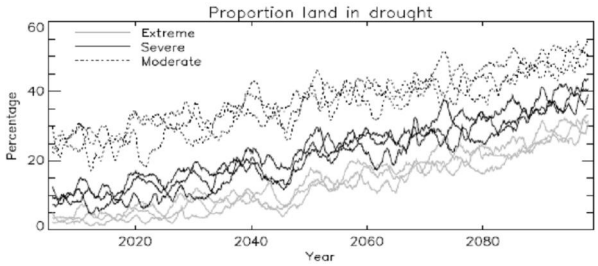
In developed societies up to half of all food sold wholesale and retail or used in the home is thrown away. Most nutrients in urban sewage systems are wasted.

Without nutrient recycling these factors point to critical nutrient shortages and sharp price increases in future, as well as to greater environmental pollution.



Knowledge drought

A newly-identified barrier to a sufficient harvest is the "knowledge drought" - a worldwide decline in agricultural R&D. This applies particularly to publicly funded science and to on-farm production research intended to benefit farmers. It means (i) the rate of increase in farm productivity globally is likely to slow and (b) less new technology will flow from the developed to the developing world. (IFPRI)



Climate change

Under climate change scenarios modeled by the UK's Hadley Centre for Climate Prediction, drought conditions could grip **up to half** the planet's land surface by the second half of the century. By way of example, the CGIAR anticipates a 50 per cent decline in South Asian wheat production by 2050 – equal to about 7 per cent of the global crop – due to drying. The Peterson Institute says "agricultural production in developing countries may fall between 10 and 25 percent, and if global warming progresses unabated, India's agricultural capacity could fall as much as 40 percent".

It used to be thought the 'fertiliser effect' of higher CO2 would offset food losses due to drought and heat, but US field trials found the yield gain is only about 10 per cent. Furthermore, crops subjected to urban ozone poisoning – caused by industrial emissions from the megacities – can lose 20 per cent of their yield.

Malthus & the Club of Rome

Two centuries ago, English clergyman and pioneer economist Thomas Malthus argued that population growth inevitably outpaces food output unless checked by moral restraint, disease or famine. His predictions were echoed in the mid-1960s when the Club of Rome warned humanity of a looming food crisis for a global population of 3 billion, a third of whom were hungry. Criticised by some because their predictions did not 'come true', it is more accurate to say that their warnings aroused the world to its peril in time for solutions to be developed. These were the C18th agricultural and C20th green revolutions.

A third global food revolution is now necessary.

The challenge

In the next two generations the world must raise food production 110 per cent – off a smaller and more degraded soils base, with two thirds the water, costlier and scarcer nutrients, using less research and under the hammer of climate change. It is the synergy between these constraints which poses the greatest challenge.

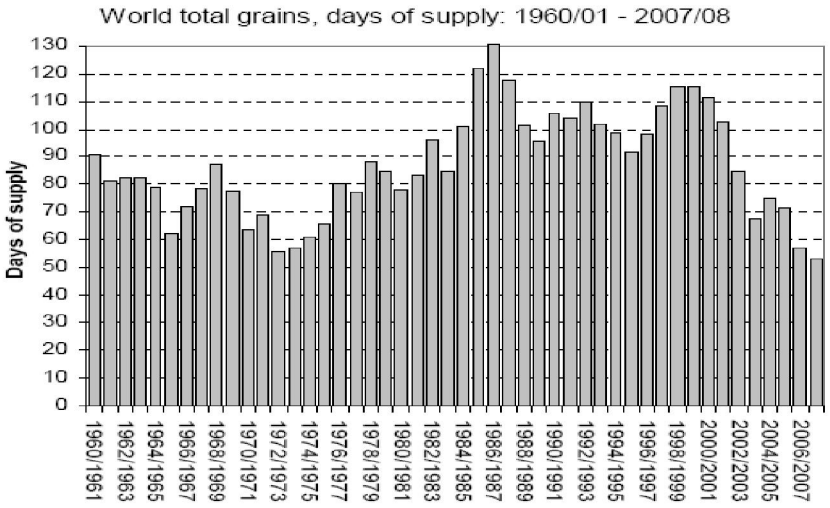
It must also contemplate difficult and unpalatable issues, such as how to reduce the human population from 9 billion to 2-3 billion by 2100 before famine, natural forces or war do it for us. Even then, those 2-3 billion will still eat enough food for 6-9 billion, unless we can curb demand for protein: while 800 million go hungry in the world today, 1.4 billion are now overweight.

Forewarnings

In 2007/08 world food security is at its lowest ebb in half a century.

Grain carryover stocks are now the lowest they have been since records began in 1960. At mid-2007 there were 53 days' supply of grain in store, half what was available in 2002.

The falling stocks indicate the world is now consistently consuming more grain that it produces.



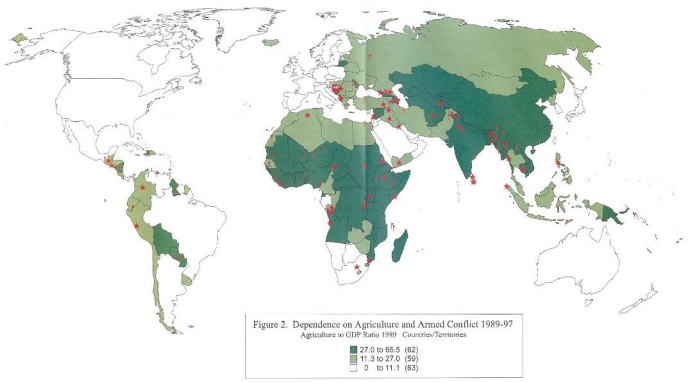
Source: NFU C

The reasons include: sharply rising demand due to economic growth, drought in key growing regions; water shortages; the collapse of marine fisheries transferring demand to meat products and hence to feedgrains; fertiliser shortages; soil degradation; and the expansion in biofuels production. (NFU Canada)

They are a forewarning of how the various constraints in this report will combine to create major regional food deficits over the coming 30-40 years.

Food & War

Since the early 1990s two thirds of all conflicts occurring round the world have had, as one of their drivers, a shortage of food, land or water. (OPRI, ACIAR)



The map indicates a high correlation between armed conflict and countries which are critically dependent on agriculture, or where food production is weak.

Political, religious and ethnic differences define who is on which side and receive the media and political attention - but the *driving force* for war is often a people's fear they cannot sustain themselves and their children and must fight others to secure the means.

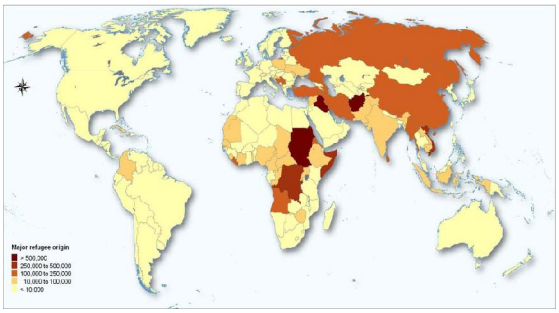
Genocides, increasingly, represent an attempt by one group to eliminate the access of others to the key resources of food, land and water.

Attempts to prevent conflict, to develop stable government or democracy which do not address the issues of assured access to food, land and water, usually fail.

Investment in global food stability is now defence spending and requires proportionate priority.

Refugees

Refugeeism is a sign of the growing tensions over access to food, land and water. Today it consists both of refugees fleeing immediate crises, within and beyond their countries, and so-called economic refugees – the better-educated who have sensed the growing instability and are moving to avoid it. After a decline, the numbers of refugees and IDPs are now rising again and totalled 32.9 million people in 2006/07 (UNHCR).



Sources of refugees: UNHCR

However the current global displacement is as nothing compared to the probable consequences of a major regional food deficit, or prolonged famine, which would release floods of refugees numbering, potentially, in the hundreds of millions. The world has not experienced such an event before and no nation would be unaffected.

Investment in global food stability is the only way to avert it.

Solutions

Sustaining food production is the global scientific challenge of our era, more urgent even than global warming.

Speculating about ways to tackle this:

1. Increase massively global public investment in agricultural research and development, with a particular focus on:
    a. exploitation of soil biota to double crop yields
    b. doubling crop water use efficiency
    c. novel crops or traditional foods 'rediscovered'

    d. polycultures of crops/pastures, perennials in mixed crop/grazing systems, agroforestry
    e. haline and acid-tolerant farming systems
2. Increase massively the rate at which new food production technologies are disseminated to farmers, especially in the poorer countries
3. Plan to peacefully limit the human population to 2-3 billion by the end of the century
4. Eliminate nutrient waste. Recycle all nutrients on farm, in industry, in restaurants, supermarkets, the home and in urban waste disposal systems back into the agrifood chain
5. Develop "green food" – alternative, low input production systems, including urban horticulture, polycultures, algae culture and plant cell bioreactors, to feed urban populations on novel foods derived directly or indirectly from waste streams but with low environmental costs compared to agriculture.
6. Develop "Green Cities" in which crops are produced on roofs, walls and in waste areas, reducing urban energy use (heating & cooling) and using waste water or stormwater. Recycle all urban water to limit demand on farm water.
7. Develop systems which convert waste CO2 and hydrocarbons into carbohydrates.
8. Promote low protein diets, vegetable consumption and low-input culinary traditions for affluent societies.
9. Use advanced genetics, agronomics and other methods to enhance food production under recurrent drought and climatic instability

System of rice intensification (SRI) halves water use while increasing yield.

10. Integrate regional natural resource management so the needs of food production dovetail with those of the environment and other human activities, avoiding conflict and enhancing sustainability.
11. Phase out commercial wild harvests, including fishing and forestry.
12. Expand recording, conservation and banking of food plant and animal genetics worldwide.

Swift's dictum:

"And he gave it for his opinion that whoever 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." (Jonathon Swift, Gulliver's Travels, 1726)