Risks and Solutions for Global Food Security©[1]

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It is forecasted there will be 9.2 billion people in the world in 2050 and this will keep climbing, reaching 11.4 billion by the mid 2060s. The world's economy will also not stop growing. China, India, Brazil, and other rapidly advancing economies will continue to demand more protein food.

Global demand for food will have to more than double to feed the additional 4.7 billion people. These people will eat 600 quadrillion calories a day. This is the equivalent of feeding around 14 billion people at today's nutritional levels. Therefore the issue for the human race over the next half century is not climate change or the current global financial crisis, it is whether humanity can achieve and sustain the required harvest.

Agriculture faces multiple critical constraints that are intertwined and serious. There are looming scarcities of just about all food production inputs – water, land, nutrients, oil, technology, skills, fish, and stable climates. This is not a simple problem, susceptible to technological fixes or national policy changes, it is a wicked problem.

LOOMING SCARCITIES

Urban Sprawl

Globally there is abundant freshwater, but nearly all of it is locked up in ice or is in places where farming is not practical. About 5,000 km^3 of natural rainfall is used to grow the world's crops; in addition 2,700 km^3 is used for irrigation – which produces around 45% of the world's food supply. Water for cities uses about 1,200 km^3. The growth in demand for municipal water supply has in recent years overtaken that of irrigation for the first time!

By 2050, 7-8 billion people will inhabit the world's cities. It is predicted they will use about 2,800 km^3 of fresh water, more than irrigation uses today. Desalination may supply some of the water but in most cases, it will be cheaper and easier to grab the farmer's water. This is already happening around the world, even in New Zealand.

Climate Change

The impacts of climate change on farm water are predicted to be considerable; more erratic rainfall over the world's grain bowls; increased evaporation from storages; shrinking river and aquifer systems; and the loss of melt water from mountain regions. The Himalayan glaciers are disappearing and the North China Plain is also running out of water. Together these regions feed 1.7 billion people now, and they must feed twice that number in future. If they fail the consequences will affect the entire planet.

Over Extraction

Six hundred Chinese cities rely on groundwater but in 400 of these the water resource is shrinking. The North China Plain, heartland of China's cereal production, waters its crops primarily from aquifers that have sunk between 50 and 90 m in recent years. They risk being exhausted within decades. In the USA, water tables in California, the Midwest, and Texas have dropped considerably due to excessive pumping. In some regions of India, groundwater tables are falling by 1-2 m a year, forcing farmers who cannot afford motorised pumps to abandon irrigated food production. Aquifer supplies are rated critical or semi-critical in 43% of India. In two out of three European cities, water is being extracted faster than it is recharged.

Worldwide, people still fail to understand that groundwater is connected to surface

[1] Adapted from Julian Cribb's presentation to the Irrigation New Zealand Conference April 27, 2010.

water. Use one and you impact upon both. Immense water bodies like Lake Chad are vanishing. Australia's Murray River fails to reach the sea 4 years in every 10. The world is becoming dotted with dried up Aral Seas.

However, to double the global food supply with today's farming systems will require around 13,000 km^3 of water, almost twice what we currently use. Today humanity uses about 7,700 km^3 of water a year. The average individual uses 1,240 tonnes of water a year – most of it in the form of food – equivalent to an Olympic sized swimming pool every 2½ years.

Peak Land

Almost a quarter of the world's farm land is affected by serious degradation, up from 15% two decades ago. The world is losing about 1% of its farmland (50,000 km^2) a year due to a combination of degradation, urban sprawl, mining, recreation, toxic pollution, and rising sea levels. If we've already lost 24% and we lose around 1% a year from here on our grandkids will have a much reduced area on which to double their food production on. As a result it is suggested the world may have already passed "peak land".

Any way you look at it, our farm land is shrinking. In 1900 every human had 8 ha to sustain them – today the number is 1.63. This is due to halve again. Between 1990 and 2005, world demand for food grew 15 times faster than the area of land being farmed.

By 2050 the area of farm land buried under cities will likely exceed the total landmass of China, and the combined area of soil diverted to recreation and other non-food activities could rival that of the United States. This is nearly all prime farm land in river valleys and on coastal plains. The word "development" must now be understood to mean the destruction of food potential. We need to start passing laws to stop it. Many of these cities will have in excess of 20 million inhabitants – yet little or no internal food production. They will be in huge jeopardy from any disruption to transport or energy supplies.

Peak Nutrients

The world leaks nutrients at every link in the chain between farm and fork. On farm it appears anything up to 50% of applied nutrients can be lost into soil, water, and the environment. The resources of mineral nutrients that have sustained the agricultural boom of the last 100 years are starting to fail. When peak theorem is applied to phosphorus it is calculated that we passed it in 1989! The world is due to pass peak oil and gas this decade. Together these spell growing scarcity and soaring prices for the primary nutrients (N-P-K) that sustain all advanced farming and horticultural systems.

Food Waste

In developed countries we waste from a third to half all food grown, while developing countries lose similar amounts post-harvest. It is calculated we waste 2,600 of every 4,600 kilocalories harvested – and therefore almost half the water used to grow it. Put another way, half the achievements of the world's farmers and agricultural scientists of the past 50 years are going straight to landfill. While one billion starve, we waste food enough to feed 3 billion!

Peak Oil

In the USA, Australia, Britain, and in 49 out of 65 of the world's oil producing regions peak oil has already occurred. Yet 51 million new cars are hitting the world's roads every year! Just as farmers have limited control over who takes their land, water, and other assets, they have limited control over who snatches their fuel.

The dependence of modern food systems on fossil fuel is such that the average citizen of a developed country eats the distillate from 66 barrels of oil a year. The high-yielding crops we are pinning our hopes on will be of little benefit if there is no fuel to sow or harvest them. One of the most pressing issues to solve is where the fuel to power the pumps, the tractors and the trucks, trains, and ships that move the food will come from in

future? It cannot come from the farm as this would cut world food output by 10 to 30% when we need to double it.

Optimistically, we may have until 2030 to solve this problem and convert the whole of the world's advanced farming systems to another energy source, algal biodiesel, hydrogen, or solar-electrics. But there is little sense of urgency from governments, particularly with the current preoccupation with the global financial crisis. By the 2040s it is highly unlikely we will be using fossil fuels in agriculture. There needs to be a crash global research effort to head off a farm energy crisis.

Peak Fish

Around 29% of world fisheries are in a state of collapse. Some say the majority could be gone by the 2040s. The FAO states "the maximum wild capture fishery potential from the world's oceans has probably been reached" and the same applies to freshwater.

If fish production cannot be doubled to meet food demand, then the extra 100 million tonnes of protein will have to come from land animals. This will require a billion tonnes more grain and 1,000 km^3 of extra fresh water. If you add this to the projected increase in meat demand of 185 mt by 2050, it means we need to discover three North Americas to grow the grain to feed these animals.

Adding climate change to this — it is predicted that drought could regularly affect 40% of the planet's land area by the end of this century. Soil moisture projections suggest that regions once thought to have massive farming potential, like Brazil, southern Africa, and the Indian grain bowl, may prove unreliable. In Asia a 30% drop in irrigated wheat and 15% in rice is predicted due to climate factors. African productivity may drop by 50% and India's drop by 30%.

Ecological Overshoot

This is the term used to describe how humanity now withdraws more resources from the planet than it is able to replace in a year. It is estimated the globe now consumes the total productivity of 1.3 Earths in food, water, energy, and other resources. If the trend continues, we will be using two planets' worth of production by 2050 and if every person on it lived and ate like a Kiwi, we would need four planets to support us all! If these predictions are even partly correct, then today's diet and agricultural systems are not sustainable. They must be reinvented.

The challenge facing the coming generation of farmers is to double the global food supply using half the water, on far less land and with increasingly depleted soils, without fossil fuels, with scarce and costly fertiliser and chemicals, amid spreading diseases and pests, whilst combating climate change.

Agricultural Science

Farmers are going to have to overcome this challenge using comparatively less science and technology. Agriculture is driving headlong into a huge technology pothole. This is the result of decisions by governments worldwide to slash resources for agricultural research and extension over the past 30 years.

The cuts have fallen in the USA, Germany, Britain, France, Australia, Japan, and even China. In 2000 developing countries spent 1.8 ¢ in every research dollar on agriculture, so unimportant had this field of science become. Between 1980 and 2006 the proportion of the world's aid budget devoted to raising agricultural productivity fell from 17 to 3%. Global funding for agricultural research, public and private, currently totals around $40 billion compared to the $1,500 billion now spent on weapons.

There has been no real increase in funding of the international agricultural science since the early 1970s, despite the world population doubling. The effects of this are evident in sagging world crop yields. The gains are now below 1% a year, which is less than half what is needed to keep the world fed. Now is the time for both strands of agricultural thought, organic and high technology, to come together to create the efficient low-input, high-yield sustainable farming system of the future. The new eco-agriculture we have yet

to invent. Creating this eco-farming is humanity's most pressing scientific challenge. The new food producing system has to be science-based. It has to be low input. It has to replenish, not destroy, and it has to work for farmers large and small.

Conflict
Modern wars are often driven by scarcities of food, land, and water. Dafour, Rwanda, Eritrea, the Balkans were all destabilised by squabbles over these resources. We know that hunger breeds war. However the wars of the 21st century are less likely to be global conflicts with defined sides, rather a mass of failed states, rebellions, insurgencies, terrorism and genocides, sparked by competition for dwindling resources. However many wars can be prevented – by using advanced farming methods to meet the rising demand for food.

Refugees
The number of displaced people has risen sharply in recent years. Future famines in regions such as Africa, India, Central Asia, China, Indonesia, and the Middle East, or any of the megacities will confront the world with tidal waves of refugees. The 50 million refugees who now flee every year are preceded by over 200 million legal migrants – the people who are smart enough to read the signs in their home countries and leave before disaster strikes.

A quarter of a billion people are on the move, every year. Yet such vast movements are as nothing to the movements of the future. These will dwarf the greatest migrations of history. Thanks to the media the entire world knows that safety, sustenance, and a good life are to be found elsewhere if you have the courage and the means to reach for them. Even places as remote as New Zealand, may face refugee tides in the millions threatening profound change to society. If we fail to secure the world's food supply, governments in many countries will collapse under the onrush of people fleeing regional sustenance disasters.

Let there be no doubt that solving the challenge of global food insecurity is the paramount concern of all nations and all people in the coming generations. The global financial crisis is trivial in comparison. Money is far less important than food. Even climate change, for all its menacing potential, is less immediately pressing.

SOLUTIONS TO CHALLENGES
There are many solutions to challenges outlined above but the four most important are:

Redouble Knowledge
There is a need to double the global investment in agricultural science. The total agriculture research and development spend needs lifting to at least $80 billion, twice what it is today. Also for every research dollar spent there needs to be another focused on knowledge transfer and uptake for the world's 1.8 billion farmers and food processors.

There needs to be a focus on creating the greatest knowledge sharing effort in history–to reach not only farmers, but also all consumers, because farmers alone will not be able to solve the challenges ahead. Using the mass communication and media systems now available this is achievable.

So where should the $160 billion to come from? Agricultural science could be likened to defence spending. Just 10% of the world's current defence budget would secure both a sustainable food supply, enhancing the prospect of peace everywhere.

End Waste and Re-Use
A simple way to enhance global food security is to reduce the colossal waste of half the food we produce. This will in turn spare water, nutrients, energy, soil, and human labour. However it means redesigning diets and the food production and distribution systems that supply them. It also means greening our cities, recycling the vast volumes of water and nutrients they presently collect, purifying them and designing entirely new urban-based

food production systems. These need to turn what we now regard as waste back into food, fuel, and other essentials.

Initiatives such as growing fresh vegetables within urban areas by hydroponic, aquaponic, or even aeroponic methods need to be established. This new urban agriculture or mass permaculture needs to be incorporated into the buildings, landscapes and social make-up of all cities.

It will involve creating entirely new industries that uses organic waste to produce vegetable, microbial, fungal, and animal cells in biocultures and turn them into healthy and novel processed foods, fuel, fertiliser, stockfeed, pharmaceuticals… A World War needs to be declared on waste and unavoidable waste has to be reused!

A New Diet

A population of 11 billion people cannot eat like Americans and hope to survive. The world's diet needs to be re-designed to one that involves far less energy, land, water, nutrients, and pollution, and one that does not kill half the people who eat it!

It is easily achievable – it means returning to the balanced nutrient intake of our grandparent's generation. A simple way to do this is to double the amount of vegetables in the diet, which could be produced in the new urban production systems using recycled water and nutrients.

There are also thousands of "undiscovered" vegetables waiting to make this a culinary adventure. The richness of nature has scarcely been tapped and our shops, supermarkets and restaurants are poor in diversity compared with what they could become.

To achieve this we must embark on an ambitious educational campaign – to install one full year, a food year, in every school on the planet. A year in which every subject, maths, language, geography, science, languages, and sport, is taught through the lens of food, how precious it is and how it is produced, where it comes from, how to eat safely, thriftily, and healthily.

Teaching food is acceptable in all cultures, races and creeds. Teaching respect for food and how it is produced is equally so. The means already exist to share these principles and educational courses – enlisting the food processing industries, the supermarkets, the cookbook writers and nutritionists, the TV chefs, restaurants and the health departments to promote the same universal messages.

Eat well but eat less. Eat more vegetables and less energy-intensive foods. Choose foods that spare our soil and water and be happy to pay more for food, so farmers can afford to protect the precious environment that produces it.

Pay More for Food

Today's global population enjoys the cheapest food in human history. It is one third the price our grandparents paid for it, and half what our parents paid. This however, is destroying landscapes, water, and farming communities worldwide – and causing colossal wastage.

There are two ways around this – first, abolish all trade barriers so food production can go where it is most efficient. Second, start paying all farmers a fair price. The prices that globalised food chains now pay farmers will end up destroying agriculture and the planets resource base if the status quo continues. The price of food is the ultimate threat to global food security. Almost everyone in society now receives fair pay – except farmers.

The coming famines of the mid-21st century will not be solved by governments, by scientists, or by farmers alone. A change in behaviour is required by every person on the planet, especially in rich and urban societies. Farmers not only grow food, the 1.8 billion mostly women farmers, also manage half the world's land, three quarters of its fresh water, and a third of its atmosphere. They need fair prices for their produce so they can do it sustainably.

Farmers, and the scientists who serve them, are the most important human beings alive. The world has forgotten this and it needs to be reminded. Delivering new farming systems and technology to all the world's farmers, paying fair prices for food, changing our eating

habits, and drastically reducing waste is a matter of global urgency. Only once these are addressed will the coming global famine be averted.

Further Reading

Cribb, J. 2010. The coming famine: The global food crisis and what we can do to avoid it. CSIRO Publishing, Melbourne, Australia.