

Julian Cribb & Associates Discussion Paper

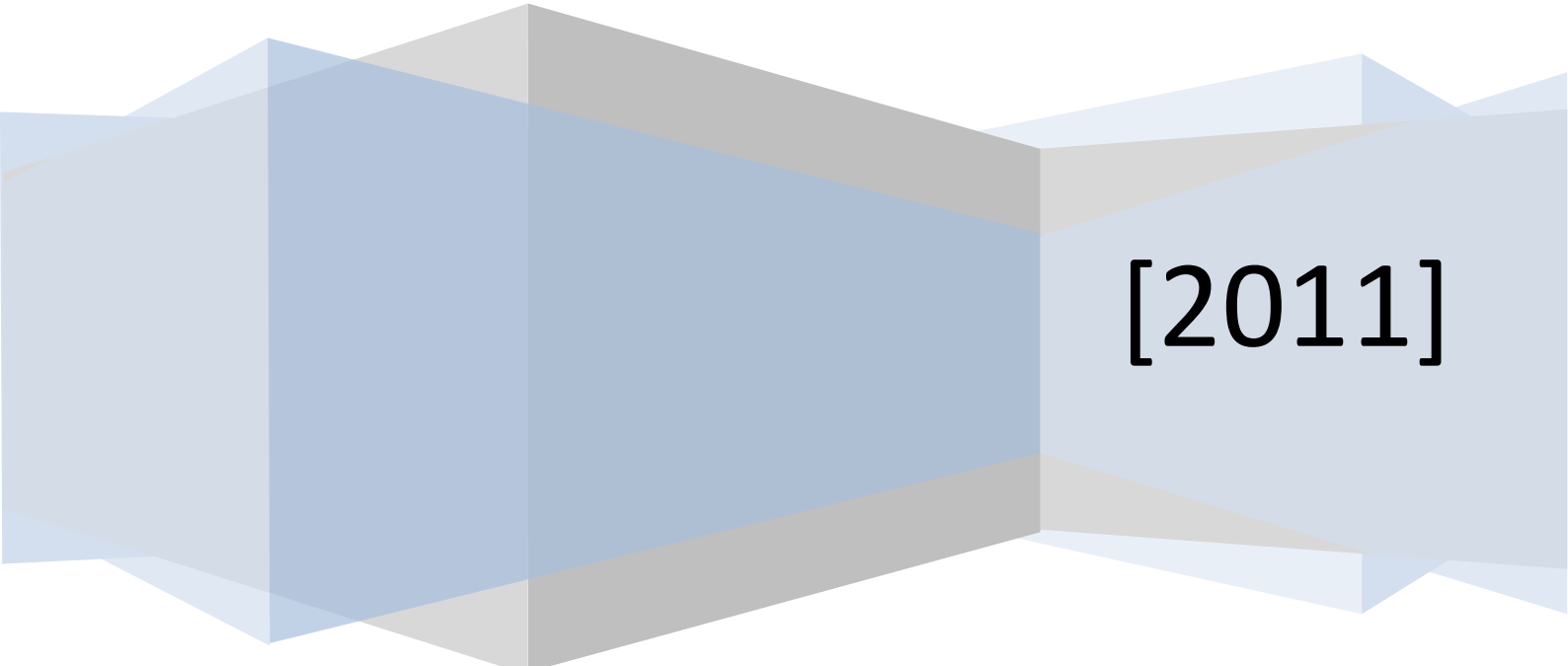
# The Coming Famine

*Risks and solutions for the food challenge of the 21st century*

Julian Cribb FTSE

October 2011

*Abstract: Feeding 10 billion people sustainably in the late 21<sup>st</sup> century will be the greatest challenge humanity and science have ever faced. While food demand will double by 2060 scarcities are emerging of almost everything required to produce it – water, land, energy, nutrients, science, fish, finance and stable climates. These challenge us to rethink food itself, to develop new farming and food production systems, diets and food products for the future that are healthy, creative, delicious and tread less heavily on the planet.*

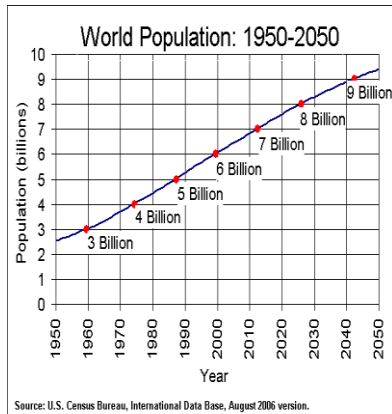


[2011]

We are facing the greatest challenge in human history – how to feed ten billion people sustainably for more than half a century.

In the first part of this essay I will explain the constraints – and you may find this a bit confronting.

In the second, however, I describe the tremendous opportunities which reinventing our food systems and diet holds for us. I trust you will find this both inspiring and motivational.



Tonight there will be 242,000 more people to dinner than there were last night.

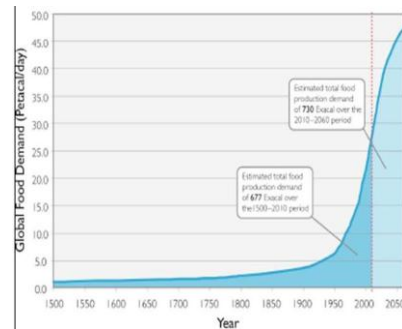
While its growth has slowed somewhat, the human population continues to expand, to 10 billion people in the 2060s and (possibly 12-16bn according to the UN's upper-end forecasts) as more babies are born and older people live longer.

In line with economic growth, consumers in China, India, Brazil and other advancing economies will be demanding more high quality food.

In recent years global food demand has risen nearly two times faster than production, driving the recent record food prices.

By the 2060s we will need twice as much food - around 600 *quadrillion* calories every single day. >

My first point is that the central issue in the human destiny in the coming half century is whether we can achieve *and sustain* such a vast supply of food.



My second point is that our food systems face *critical* limitations. Not just one or two, but a whole constellation of them, each playing into the other.

There are emerging scarcities of almost everything we need to produce good food – water, land, nutrients, oil, technology, skills, fish, finance and stable climates.

Fix one, and you often make the others worse.

So this is not a simple problem that can be easily solved with some new technofix or national policy.

It is a *wicked* problem ... of vast complexity.

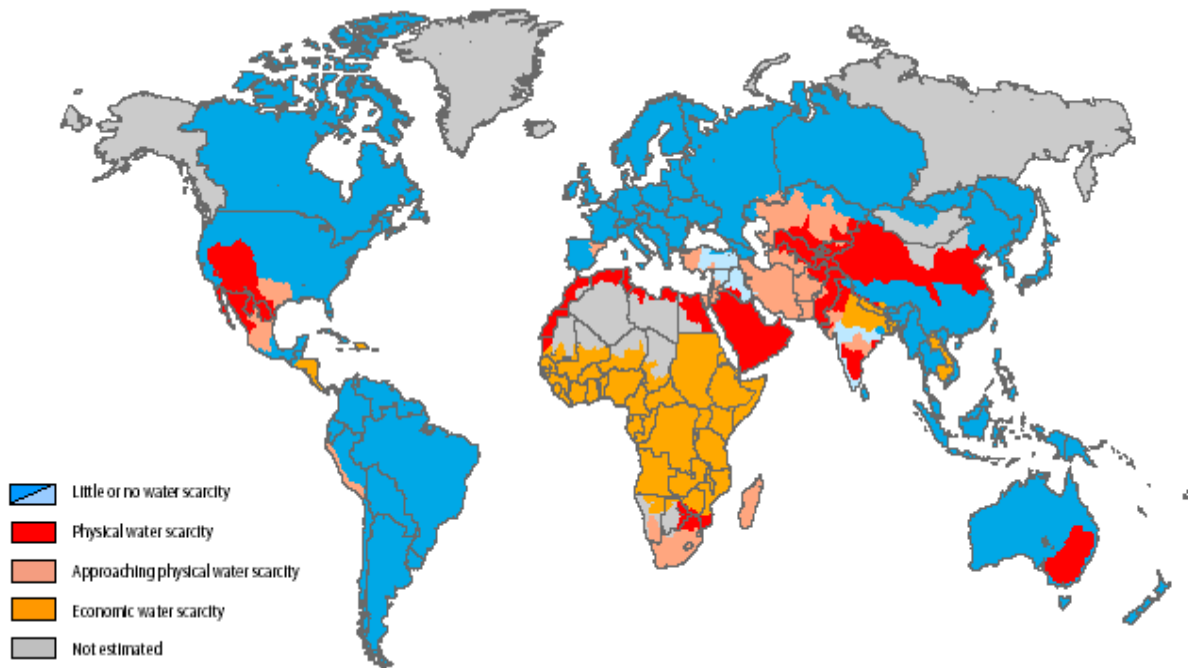
### Peak water

For example, by 2050, 7-8 billion people will inhabit the world's cities. They will use about 2800 cubic kilometres of fresh water a year – more than the whole of irrigation farming uses today.

At the same time the global resources and energy sector will devour twice its present share of the world's fresh water.

Cities and energy corporations are already meeting their needs by taking the farmer’s water, with little thought for how this will affect future food production.

Then there is the slice of farm water that climate change is stealing: rainfall over in the world’s great grainbowls, evaporation from soil and dams, dwindling lakes, shrinking aquifers or the loss of icepack from mountain regions.



By 2050 6 billion people will live in conditions of moderate to acute water scarcity. IWMI director general Colin Chartres says “Current estimates indicate that we will not have enough water to feed ourselves in 25 years time.”

Worldwide, groundwater levels, lakes and rivers are dropping as they are pumped dry. Immense waterbodies like Lake Chad are simply vanishing. Large rivers no longer reach the sea.

The Himalayan glaciers are indeed disappearing. On the North China Plain, the north Indian plain and in midwestern America, groundwater is being mined at such a rate that it will largely be gone in 15-20 years.

These regions feed 2 billion people now - and must support 4 billion in future.

Today, humanity uses about 7,450 cubic kilometres of water a year.

Each of us consumes one Olympic swimming pool of water, every thirty months – three quarters of it in the form of food.

>

Food	Litres to grow
Slice of bread	40 litres
Tomato	13
Cup of coffee	140
Glass of milk	200
Egg	135
Glass of wine	120
Kilo of grain	1500
Cotton T-shirt	4000
Kilo of chicken	6000
Kilo of beef	15000

The cup of coffee you enjoyed this morning took fourteen buckets of water just to grow the beans.

To put our fresh water consumption in perspective, over a lifetime we *each* use enough water to float the USS Enterprise, a huge aircraft carrier.

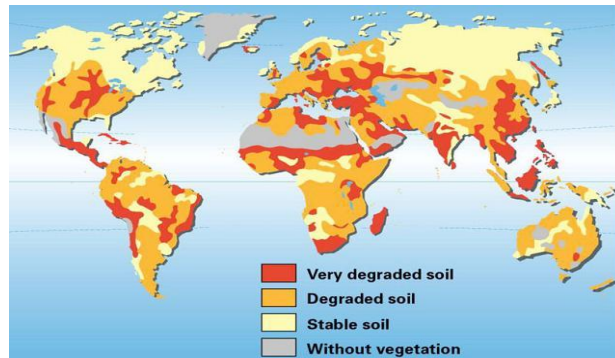
You can see that doubling global food production is not just a simple case of doubling crop yields – when the available water is likely to more than halve.

### Peak land

As with water, so with land. Today, one quarter of the world's farm land is degraded. (FAO 2008)

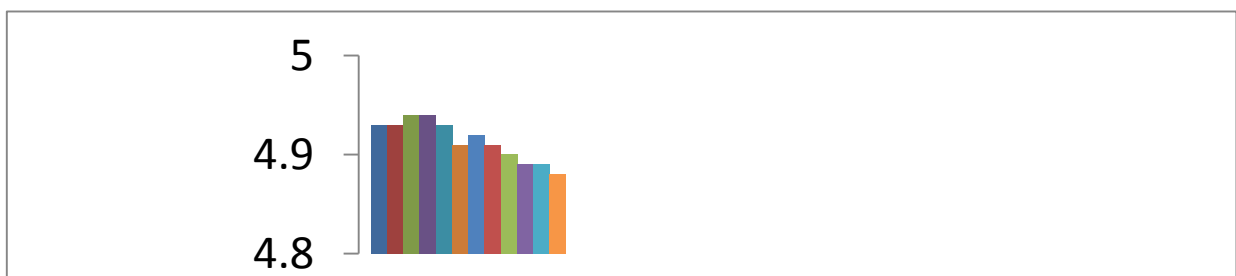
A recent satellite study found that the world is losing one per cent of its farmland every year.

We currently lose 750 tonnes of topsoil every second – a clear warning that present food production systems are unsustainable in the long term.



If we've already lost 24% of our land and we keep on losing 1% a year from here on, you can work out for yourself how much land our grandkids will have left to double their food production on.

FAO statistics (below, in trillion ha) show that the area of land farmed worldwide has diminished in 9 out of the last 10 years – despite the stimulus of high commodity prices. We may already have passed peak land.



By 2050 the area of farm land buried under cities will equal the total landmass of China.

The total area of land diverted to recreation could rival that of the United States.

This is nearly all prime farm land in river valleys and on coastal plains – permanently priced out of agriculture.

The word “development” has a new meaning: the elimination of food potential. We need laws to stop it - or food prices will soar.

Urban sprawl has another, hidden impact: it drives farming out into dry, marginal and unreliable country. This increases food insecurity, carbon emissions and land degradation.

But there is an issue more perilous still. The world is building many cities with 20, 30 and even 40 million inhabitants. Most of these grow little or none of their own food.



They are sustained by a mighty river of trucks that flows every night to restock the shops and supermarkets.

What will happen if - due to an oil crisis, a local war or natural disaster - that river of trucks fails to arrive, even for a few days?

The modern metropolis cannot survive more than two or three days without oil and without food.

Besides rethinking farming, we must also to rethink the city.

### **'Peak phosphorus'**

The world currently loses close to 90 per cent of its nutrients all along the chain from farm to fork.

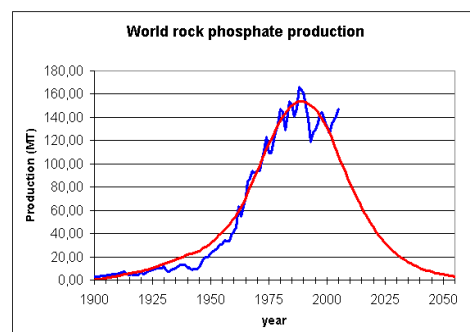
On farm anything up to half of the fertiliser can be lost. Another half of our nourishment is lost in the food chain and waste disposal system.

This wastage is destroying lakes, rivers, coastal areas and creating dead patches in the oceans.

Modern civilization is largely dependent on finite mineral nutrients mined from rock or soil. There are no substitutes for these.

No phosphorus, no food.

Because these minerals are finite they will sooner or later become scarce. Just when is currently a fierce debate among scholars. But like peak oil, peak phosphorus is lying in wait for humanity, sometime this century.



When it happens, millions of farmers will be unable to afford fertiliser. Unless we find new sources of nutrients, food prices will skyrocket.

We are the first generation in human history to throw away half our food.



The picture shows the USDA's estimate of the food trashed by the average American family every month. The same applies in Europe and other developed societies.

In the Third World, up to half is lost postharvest to insects and moulds.

So, half of the hard work of the world's farmers goes in the garbage.

While a billion people go hungry and a child dies from malnutrition every five seconds, we waste food sufficient to feed 3 billion.

Our generation, it appears, has lost its respect for food.

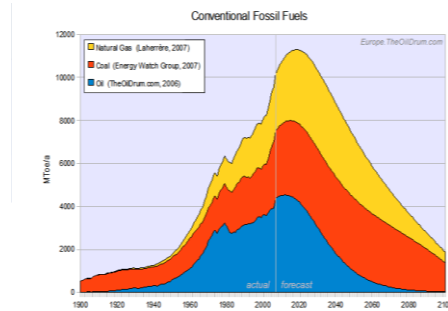
We have also lost our thrift – a basic human survival strategy throughout all our history.

### Peak oil

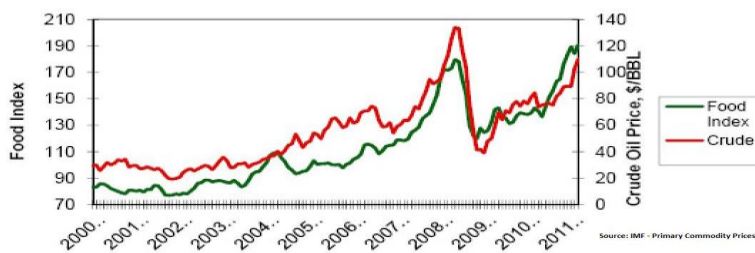
Global peak oil was in 2006, according to the International Energy Agency. It has certainly occurred 50 out of 65 of the world's oil producing regions – including, possibly, Saudi Arabia.

Yet 61 million new cars will hit the world's roads this year.

Whether the oil crisis happens next week or next decade, it is a certainty – and it will have a huge impact on the cost of farming and price of food worldwide



The modern food system depends totally on oil. Food prices and oil prices are inextricably locked together (below).



In the developed world we each 'eat' four litres of diesel fuel a day.

Globally, farm fuels are not a solution, as they push up food prices.

In theory you can grow enough fuel on farm to run all the tractors, but that would cut world food supplies by 10 per cent. If you grew enough to transport food to the cities, it would cut world food supplies by 30 per cent – right when we aim to double them. The wicked problem is again evident.

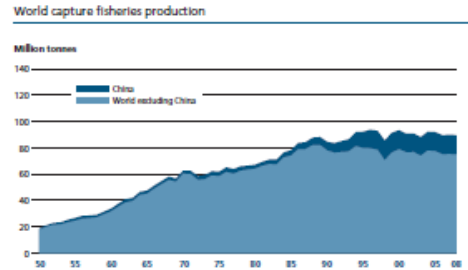
Governments and consumers seem blissfully unaware of the risk which global oil scarcity spells for global food security.

We urgently need to establish a global research program to convert farming systems to another energy source: algal biodiesel maybe. Or 2<sup>nd</sup> generation biofuels. Or hydrogen. Or solar electrics. Or we will all pay the price at the food store.

### Peak fish

Fisheries scientists report a third of world fisheries have already collapsed and another 40 per cent are in trouble.

It now appears that the peak of the world's ocean fish catch happened in 2004. As FAO (2008) put it: "the maximum wild capture fishery potential from the world's oceans has probably been reached". >



The dramatic expansion in fish farming has, so far, only managed to maintain seafood output – not increase it. There are very great opportunities here – but a major research effort is also needed.

If we cannot double the fish catch, then we will have to get the extra 100 million tonnes of protein from land animals or fish farms.

At the same time, FAO expects global meat demand to rise by 185million tonnes by 2050.

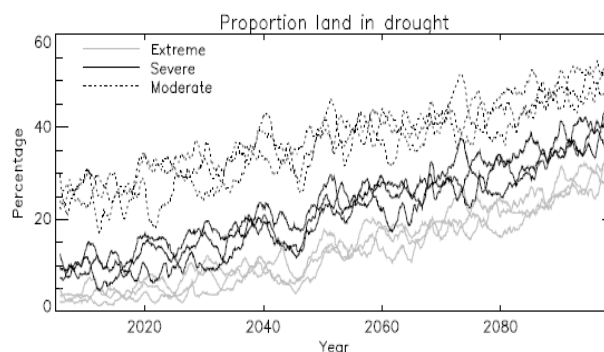
To put the size of the food challenge in perspective, to satisfy the world's increased protein demand by 2060 means we'll need to find the equivalent of *three more* North Americas to grow enough grain to feed all these livestock.

### Unstable climates

We must produce this extra food at a time when the climate in which agriculture arose is changing, maybe forever. "Our crops are adapted to climates which are about to become extinct," says Cary Fowler, who runs the Svalbard Seed Vault.

The UK's Hadley Climate Centre projects that 40 per cent of the planet could be in regular drought by 2100. >

Their soil moisture projection suggests that regions considered to have big farming potential, like Brazil, southern Africa and the Indian grain bowl, may prove unreliable, as the world warms 4-5 degrees by the end of the century.



The current broad consensus of the experts is that climate impacts could cut global food production by around 25% - right when we are trying to double it. Another example of the wicked problem.

## Knowledge drought

We are asking our farmers to meet all these challenges with less technology to help them do so.

Worldwide, agriculture is driving into a huge technology pothole.

This is because national governments, aid donors and academic institutions, have frozen or cut funding for domestic and international agricultural research and extension over three decades. This has led to a decline in the rate of gains in crops yields and farm productivity globally. >

It is a major reason why food production is not keeping up with growth in food demand - and why prices are rising.

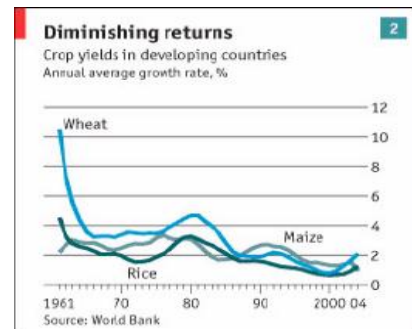
In the year 2000 the rich countries spent just 1.8 cents in every research dollar on ag research, so unimportant has food become to them.

To give you a comparison: the world spends about \$50 billion a year on food and farming science. That's about what we were investing when there were only 3.5 billion people.

Today the world also spends \$1,600 billion a year on new weapons.

To develop the sustainable eco-agriculture of the future, and the sustainable healthy diet, we need massively more investment in food and farming science and technology and in knowledge sharing.

We can easily afford this. By investing just one tenth of what we now spend on weapons.



## Capital drought

FAO says that to double global food production will require an investment of around \$90 billion a year for the next 50 years.

Unfortunately, with globalised food chains driving farm prices down, and globalised suppliers driving farm costs up, most farming worldwide is unprofitable.

As FAO itself points out, nobody in their right mind is going to invest \$90bn a year in an industry that makes big losses.

Millions of farmers are recognising this and leaving the land. They are telling their children not to grow food. This process risks throwing one in every five of the world's citizens out of work – 1.5 billion people – and out of their home, with incalculable consequences for global security.

If we are to double world food production, there must be a fundamental change in the economics of agriculture.

The signal to food producers to invest must change from a negative to a positive one. It must apply to smallholders as well as large-scale high-tech farmers.

## The challenge

The challenge facing the world in the next two generations is to double the global food supply – using less water, less land, without fossil fuels, with more costly fertilisers and chemicals, with insufficient capital and technology, and under the hammer of climate change.

This is a daunting task.

But we must not let ourselves be daunted.

For it is also a magnificent opportunity for all those involved in food.

It is the challenge of our Age.

It is a chance for all countries to join in pioneering new farming and food production systems and a truly sustainable, healthy and delicious new cuisine.

## Food wars

The reason is simple: if we fail, the consequences will affect every person on the planet.

Two thirds of recent wars were driven, at root, by scarcities of food, land and water.

Dafour, Rwanda, Eritrea, the Balkans were all destabilized by fights over these resources. Further back, the French and Russian civil wars both grew out of bread crises. We *know* that hunger breeds war.

The UK Ministry of Defence, America's CIA, the US Center for Strategic and International Studies and the Oslo Peace Research Institute all identify food scarcity as a trigger for revolution, government collapse and wars.

The riots that overthrew governments in Egypt and Tunisia in 2011 both began with a public outcry over food prices.

Globally, food prices are around the highest level on record, peaking twice in three years.

But the good news is that many wars and government failures can also be avoided – by successfully meeting the world's need for



sustenance.

Investing in food and farming science is, in other words, *defence spending*. It merits equal priority.

Recent years have also witnessed a surge in the number of refugees and legal immigrants. There are now a quarter of a billion refugees and legal migrants moving round the planet in search of new homes, food and security every year.

Future famine in any significant region – North Africa, India, Central Asia, China, Indonesia, the Middle East or any of the megacities – will confront the world with tsunamis of tens, maybe hundreds of millions of refugees, swamping neighbouring and even distant countries. It will affect everyone.

Let there be no doubt that solving global food insecurity is the great challenge of our time.

### **Some solutions**

We must never forget that big challenges also contain huge opportunities. That we have solved similar problems before – and can do so again, provided we act with resolution and foresight.

Here are some of the most important – and exciting solutions.

To surmount the food challenge we need to reinvent three things: agriculture, the world diet, and cities.

Combining the best ideas from modern and organic farming we need to develop a science-based eco-farming that grows far more food on far less land, water and inputs. Scientifically speaking, this is not a trivial task.

We also need to create a new, healthy diet for humanity that treads less heavily on the planet – and which does not kill half of all consumers, as does the present western diet.

And we need to redesign our cities so they recycle water and nutrients back into traditional and novel forms of food production.

### **New knowledge**

We must double the global investment in agricultural and food science to \$80 billion a year.

Then we need to spend another \$80 billion getting the new knowledge into the hands of the world's 1.8 billion farmers, large and small.

This will be part of the greatest knowledge sharing effort in history – reaching not only farmers, but also all cooks, food processors, restaurants and 8 billion consumers.

Using the internet, social media and advanced communication systems, I believe this to be completely feasible.

And where is the \$160 billion to come from?

Food science IS defence spending. Just ten per cent of the world's current weapons spend would secure both a sustainable food supply – and enhance the prospects of world peace by curbing the proliferation of weapons and reducing disputes over food, land and water.

An easy way to improve global food security is to end the colossal waste of half the food we currently produce - by recycling nutrients at all points in the food and waste chain back into farming and other food production systems.

### **A new agriculture**

Since present farming systems lose soil, water and nutrients and require large amounts of fossil energy they are not sustainable in the long run and must change in any case.

The new eco-agriculture will be a fusion of the best ideas and experiences of both advanced high-tech farmers and organic farmers, tested and proven in a scientific framework.

It will aim to produce twice as much food – with half the water, land area, nutrient, chemical and energy inputs. Besides using all currently available agricultural technologies this will require massive global reinvestment in soil microbiology – which is probably the source of the next great leap in farm productivity: the so-called 'doubly green revolution'.

It will be accompanied by novel forms of food production such as urban agriculture (advanced and smallholder), biocultures based on recycled urban nutrients, aquaponics (fish + vegetable systems) and algae farming (for food, feed, fuel and pharmaceuticals).

We need a worldwide conversation among all farmers and agricultural scientists to develop this new style of food production.

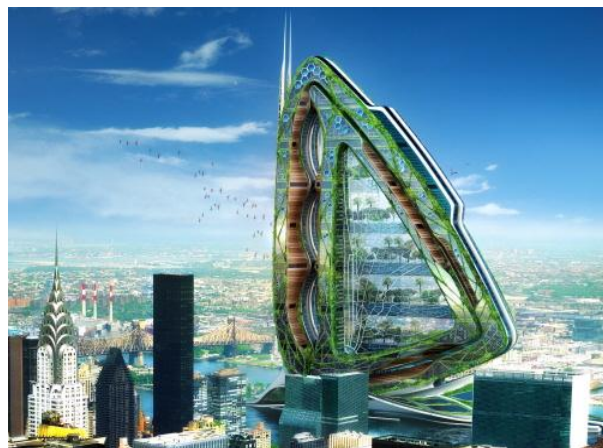
### **Urban farms**

We must green our cities, developing entirely new urban-based food production systems, both large- and small-scale, high-tech and low.

This will turn what we now waste back into food, fuel and other essentials.

It will involve growing large quantities of fresh vegetables, fish and small livestock in cities using hydroponic, aquaponic and other intensive systems.

This new 'urban permaculture' must become the central design element in the buildings, landscapes, industries and social milieu of our mighty cities. >



## Biocultures

We can create entirely new food industries that use organic waste to produce vegetable, microbial, fungal and animal cells in biocultures and turn them into healthy and novel foods.



This may not sound very 'gourmet' – but it will protect the megacities from the danger of starvation, reduce food miles and carbon emissions.

These novel foods can also be designed to directly address conditions like diabetes, heart, disease, cancer and obesity in individuals.

I here call for a World War on Waste.

Let us design food systems for the future that do not waste or, if they do, that then reuse.

## Healthy diets

We must refashion the world diet - to one that doesn't actually kill half the people who eat it, as does our present one. To one that uses less soil, water, energy, fertiliser and chemicals to produce

This diet will be lighter, fresher, healthier. It will be vastly more diverse, will contain far more plant foods, and less high-energy foods.

We are at the brink of an explosion in food diversity.

A culinary and farming revolution like no other we have ever seen or imagined.

There are more than 23,000 edible plants on planet earth – of which we currently eat only a few hundred.



The richness of nature has scarcely been tapped.

Our menus, supermarkets, cookbooks and restaurants are poor in diversity compared with what they will become.

This has the promise not only of a revolution in farming diversity but a grand culinary adventure and a breakthrough for human health and global sustainability.

### **Future meat**

People will always want to eat meat.

But with the rise in grain and energy prices and the drying of the world's grain bowls, it is likely that livestock production will refocus in the world's grasslands and rangelands, while food grain production will concentrate in regions favoured by good soils and reliable rainfall.

Future meat will be clean, healthy, natural-pasture reared and largely organic – by popular demand. But it will be more expensive, reflecting the true cost to the environment of producing it and paying a better income to the producer.

It will use advanced technologies like 'precision pastoralism' to ensure it is sustainable.

It will revegetate the world's grasslands, rangelands and deserts.

It will lock up billions of tonnes of carbon and increase the amount of water stored in the landscape.

We can also farm parts of the deserts, using novel systems that use sunshine and salt water.

### **A food year**

To achieve all this we must reshape the attitudes and expectations of 8 billion urban consumers towards food.

This calls for the world's most ambitious educational campaign – one full year, a food year, in every junior school on the planet.

A year in which every subject – maths, language, geography, science, society 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. How to help ensure it never fails.

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 universally.

It is the task of all farmers, chefs, food scientists and teachers to be leaders in this campaign, to engage the food processing industry, the supermarkets, the cookbook writers and nutritionists, the TV chefs 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. Be happy to pay more for such good food, so our farmers can safeguard the precious environment that produces it.

### **Meeting the challenge**

The challenge of doubling the world's food supply is great.

But the opportunities which flow from it are greater still.

By sharing knowledge globally and redoubling research, we can develop new science-based eco-farming systems

We can build healthier and more sustainable diets.

We can design cities that do not waste.

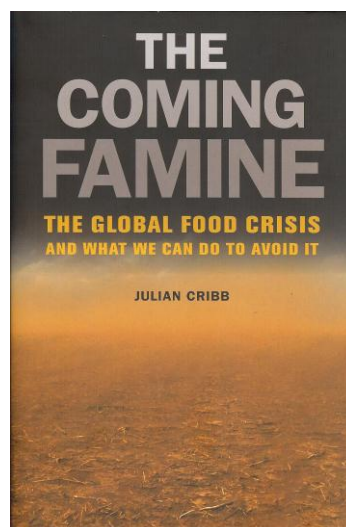
And we can pay farmers, fishers and food producers a fair price so they can safeguard the Earth that feeds us.

This is more than an inspiring challenge.

It is one on which depends the future prosperity, security, stability, peace and happiness of civilization.

**ends**

**More information: 'The Coming Famine: the global food crisis and what we can do to avoid it' by Julian Cribb** <http://www.ucpress.edu/book.php?isbn=9780520260719>



<http://www.amazon.com/Coming-Famine-Global-Crisis-Avoid/dp/0520260716#>