Julian Cribb & Associates

The Age of Food

Abstract: Dramatic evolution in the global diet, cuisine and consumer preferences will, over coming decades, change the foods we eat more profoundly than at any time in history. Emerging scarcities of water, soil, nutrients, fish and climate instability along with concerns about health and sustainability signal a major shift in the world food production paradigm from extensive, open-air and rural to intensive, indoors, urban and high tech. However, amazing new food and water opportunities await Tasmania in this, The Age of Food.

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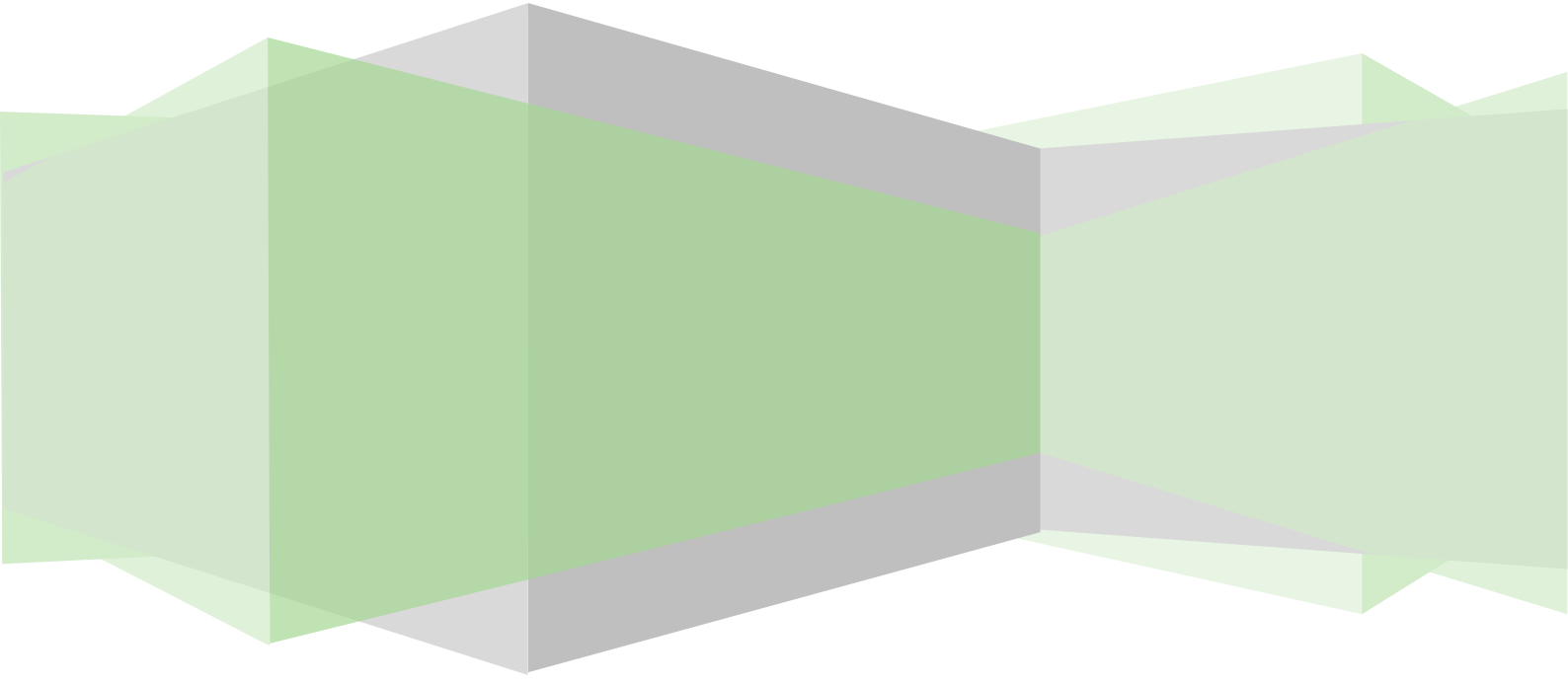

Slide 2: food will change

Food is poised to change – more profoundly than in any era of human history.

This food revolution is arising out of fierce demand and resource pressures building up in the global food system, coupled with the advent of spectacular new technologies and new trends in farming, health, recycling and sustainability.

Today I make several forecasts about the future of food, based on emerging risks, opportunities and constraints.

Many foreshadow magnificent new farming , investment and career opportunities in this, *The Age of Food*.

Slide 3: a wicked problem

Tonight around 130,000 more people will sit down to dinner than dined last night. By the 2060s we will have 10 billion mouths to feed.[i]

It isn't just babies being born – it's also old people living longer. On average a long-lived rich person eats 35,000 more meals than a poor one.

To meet this vast demand, global food availability must double by the 2060s.

But everything we need to do this by traditional means is running out: soil, water, nutrients, energy, technology, fish, capital and a stable, reliable climate.

This clash between great demands and greater scarcities makes food the challenge of our time.

The multiple stress on food security is not well understood, by governments or consumers.

Like the Indian blind men in the fable, they see only parts of the beast.

Slide 4: peak water

The world is already at, or close to, 'peak water'.

In China, India, the US and Middle East and North Africa, groundwater is being mined to grow food faster than it replenishes.[ii] NASA says that, of the world's 21 great groundwater basins, 13 are 'in distress'.

Rainfall in the great grain bowls is becoming less reliable; snowpack and glaciers on high mountain chains are shrinking; lakes, rivers and aquifers in dry lands are vanishing.[iii]

Water systems in general are severely overexploited, contaminated, fragmented, disputed, subject to leakage, evaporation, decaying infrastructure and corruption, in almost every country on Earth.

If nothing changes in how we manage our most precious resource, by 2030 demand for water will outstrip supply *by 40%*, a UN report warns. [iv]

The number of people facing acute water stress one month or more a year already exceeds 4 billion [v]

Slide 5: soil

As with water, so with soil.

Scientists estimate the world loses from 40-75 billion tonnes of soil a year, mostly due to farming.[vi]

The University of Sheffield says we have shed a third of the world's topsoil since 1975. [vii]

Satellites show the world's farm land area shrinks by about 1 per cent a year.[viii]

If this continues, scientists warn, the world may run out of good arable soil within 50 years.[ix]

Collapsing farming systems breed war.

Conflicts have already erupted in countries such as Syria, Nigeria, Rwanda, South Sudan, Yemen, Somalia and Eritrea.

The solution is to change how we produce food – and how we reward farmers.[x]

Slide 6: diet

The modern diet is not healthy.

In developed countries like Australia, three people in every four now die by their own hand – the one holding the fork – from a range of chronic food-related diseases: heart disease, cancers, diabetes, obesity and the like.

The important thing to remember is that food deaths are preventable deaths.

The Lancet Commission says the world diet must - and will -change.[xi]

Slide 7: Biosphere

Our insatiable hunger has cleared half the Earth, emptied the oceans and is the chief exterminator of wildlife.

People and livestock now account for 96 per cent of the land vertebrate biomass on the plant. [xii]

Says Harvard biologist E.O.Wilson: "We are tearing down the biosphere".

But there is an answer, one in which farmers can help save the planet. More later.

Slide 8: cities

By 2050 the world's cities will house 7 billion[xiii] and cover an area of land the size of Australia.

Many cities will have 20, even 40 million citizens. Guangzhou-Shenzen will have 120 million inhabitants.[xiv]

These mighty cities have one terrible flaw.

They cannot feed themselves.

They rely on a river of trucks coming every night to restock the shops.

Any break in the flow – an oil crisis, a war, a flood or storm – and a giant city could starve.

The solution is for cities to grow *far more of their own food*.[xv]

Slide 9: nutrients

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

This is what the typical family throws in the trash every month.

Almost half of the efforts of the world's farmers now goes to landfill.[xvi]

This is neither moral, nor economic nor sustainable.

Food today is founded on a culture of waste.

This must change – because world supplies of fertiliser minerals, which underpin the modern food system, are running down, posing another threat to food security in the mid-century.[xvii]

The obvious solution is to recycle *all* our waste nutrients back into food production. [xviii] As our ancestors did.

Slide 10: fish

The world fish catch peaked in 1996 and has been declining for over 20 years. [xix] Also most sea fish are now contaminated with plastic and large areas of the ocean are dead from pollution

So we are not going to get another 80 million tonnes of wild harvest fish from the sea, to meet the doubling in world food demand.

Visionary solutions are called for, which I will describe.

Slide 11: R&D

For quarter of a century the world scientific effort in food and agriculture has stagnated.[xx] It is among society's lowest science priorities.

This is crippling crop yields, our ability to adapt to climate change and develop healthier diets.

Global investment in food and agricultural R&D is about $70 billion.

Yet we spend $1.8 trillion each year on new weapons.[xxi]

So humans now invests 25 times more in better ways to kill one another than we do in better ways to feed one another.

It is time for a new focus on building world peace through food – not war.

I call for the world to invest a fifth of its current military spending in new food science and technology, especially on water and nutrient recycling.[xxii]

Slide 12: eating planet

To summarise:

Every meal served now costs the Earth: 10 kilos of topsoil, 1.3 litres of oil, 800 litres of water, a third of a gramme of pesticide and 3.5 kilos of CO2.

We are devouring our planet in order to feed ourselves.

This cannot be sustained.

It will not feed a population of 10 billion in a hot world.

It *has* to change.

Slide 13: climate

The mild Holocene climate, which gave birth to agriculture, is extinct.

It is never coming back.

A new report in Nature says that food shocks on land and sea are increasing worldwide. [xxiii]

Two degrees of global warming – now unavoidable – will make outdoor harvests unreliable in the world's great grain bowls. In India, for example, grain yields could fall as much as 45 per cent.[xxiv]

Scientific estimates indicate that, without adaptation, 5 degrees of warming could halve global food production. [xxv]

This will hit every person on the planet

The food dimension of climate change will be the biggest personal impact of all.

It will drive economics, geopolitics, migration, refugee crises and war for much of this century.

Slide 14: challenge

The challenge of feeding the world over the coming century is vast.

But the opportunities that arise from it are boundless.

Everywhere I travel I find clever farmers, scientists, cooks and entrepreneurs reinventing food, how and where it is produced, prepared and sold.

Let us explore these opportunities.

Slide 15: solutions

Solutions to the global food challenge revolve chiefly around the following management changes:

- Recycling all water and nutrients
- Eliminating poisons, health risks and cruelty
- Transitioning our diet from unsustainable to sustainable, unhealthy to healthy

- Capitalising on new technology
- Moving half of food production back into the cities to recycle their water and nutrients.

In coming decades the world diet must shift from one that is mainly European (meat and grain) to one that is largely Asian (seafood, dairy and vegetables), from one that is waste-driven to one that reuses all its nutrients and water. From one that is entirely rural to one that is partly urban.

On this transition depends the future of our civilisation.

Worldwide, smart farmers and businesses are already investing ahead of the curve. Here are some examples.

Slide 16: sky farms

The need to feed the megacities is sparking spectacular growth in urban food production. [xxvi]

Modes range from high-tech glass skyscrapers producing vegetables, fruits, small livestock and fish – to the large-scale cultivation of fresh foods on urban roofs and walls, to a renaissance in backyard, balcony, private allotment and public food garden production.

Aquaponic farms are sprouting from Norway, Iceland and Canada, to America, France, New Zealand and Australia.[xxvii] In Japan's Kanto foodbowl there are already over 200 urban farms. [xxviii]

A 4000-acre 'food park' is proposed for the heart of Rotterdam[xxix], in Stockholm government buildings will grow food [xxx], a glass sphere is going up in Linkoping, Sweden[xxxi] and an aeroponic farm growing hundreds of tonnes of fresh leafy greens in New Jersey [xxxii].

These are *all* novel forms of farming, using little or no soil and water.

Smart hospitals are culturing fresh vegetables on the roof to feed recovering patients on fresh, healthy diets. [xxxiii]

Smart restaurants are offer patrons salad greens harvested fifteen minutes ago. [xxxiv]

In Singapore, elderly retirees grow their own food in vertical apartment farms.[xxxv]

Slide 17: agritecture

A new food production paradigm is emerging worldwide from a fascinating blend of irrigation agriculture with architecture, art with science.[xxxvi]

Elaborate structures specially designed as farms as well as food production as well as homes and workplaces are transforming our thinking about city life.

Slide 18: intensive farms

In Australia, Blue Farms produces fresh fish and herbs for a major national supermarket chain using conveyor-belt aquaponics. [xxxvii]

In Japan, an old Sony factory is churning out 10,000 lettuces daily. [xxxviii] In Norway Miljogartnieret produces 2000 tonnes of tomatoes and peppers a year. [xxxix] In Dubai, Emirates Airlines is building a vertical farm to grow 5 tonnes of fresh food a day.

These enterprises exemplify the urban food systems of tomorrow.

They involve: recycling of nutrients, water and energy, precision crop feeding, low or zero use of chemicals, zero use of soil, biological pest control, hospital-style hygiene, specialty crops and elite quality control.

They are backed by a growing network of online retailers, supplying consumers and restaurants with same-day fresh produce and meals direct.

Slide 19: ponics

Technical advances in *hydroponics, aeroponics* and *aquaponics* offer new ways to produce high yields of fresh, nutritious food *locally* from a fraction of the water, land area or energy use of traditional farming systems and for a fraction of the cost.

Social media are seething with clever new business ideas in this space. I urge you to explore them.

Slide 20: floating farms

As land prices soar, farming is taking to the sea, combining the ancient Aztec idea of floating farms with 21st century solar and desal technology to grow fresh land vegetables as well as fish on high tech floating platforms.

This novel form of irrigation will help to feed megacities located on the world's coasts – places like Mumbai, Singapore, Shanghai, San Francisco, maybe even Sydney.

Slide 21: desert farms

The looming world crisis in soil and water will be solved in the same way – by solar/desal and hydroponic irrigation systems in desert regions such as western China, north India, the Middle East, North Africa and Central Asia.

In South Australia, Sundrop Farms is using sunshine to desalinate salty groundwater and grow crops of tomatoes year-round in a climate-proof setting.[xl]

Slide 22: microfarms

Living in a high-rise apartment is no longer a barrier to being a farmer, says Australian journalist Indira Naidoo.

Microfarms are taking off worldwide as urbanites rediscover the joy, the satisfaction and the health benefits of raising their own crops and livestock.

Microfarms range from the hippy to the hipster, to the high tech. Even supermarkets are now installing them. For the fashion-conscious urban farmer, Ikea offers you this attractive green sphere.

Slide 23: insects

The United Nations is promoting insects as food. Round the world but especially in Asia, insects are catching on.[xli]

Entomoculture can also play a vital role in recycling food and crop waste, providing quality feed for poultry, fish and people.

Slide 24: cowless meat etc

A milestone in the future of food was the 2013 production by Maastricht University of the world's first test-tube sausage, and the world's first hamburger grown from animal stem cells.

Cultured meat is real meat – but uses far less soil, water, fertiliser, energy, chemicals and carbon. It is potentially healthier and safer to eat, cheaper to the consumer and cruelty-free to both farmers and animals.

It just never went moo.

It is ideal for urban production.

I predict that by the 2030s cultured meat will take over the bottom end of the meat market – as filler for pies, sausages, snackfoods and so on.

There will also be henless eggs, pigless bacon, chookless nuggets and fishless fish.

And of course, cowless milk, cheese and dairyfoods.

If you doubt that cultured foods will catch on, look at your clothes. Sixty years ago, nobody wore synthetic clothing – today everyone does.

Slide 25: biocultures

Biocultures will transform food in the coming 20 years.

Cell culture has been used in agricultural and medical science for decades. This technology is now emerging at industrial scale to grow healthy food and recycle waste.

Cells from plants, fungi, microbes and animals can be cultured en masse in bioreactors – and turned into edible, nutritious and even delicious foods using recycled water and nutrients.

If you think about it, cell culture is just farming on a very small scale. It's a big new investment opportunity.

Huge strides are also being made by companies around the world in the 3D printing of food from raw ingredients. This is another future urban industry, with potential ranging from 5-star restaurants to fast food outlets and vending machines.

Importantly, these novel foods can be precisely tailored to the dietary needs of the consumer – protecting us from killer lifestyle diseases based on our genetic risk profile.

Slide 26: Novel plant foods

Believe it or not, our civilization subsists on only 200 or so food plants – and relies primarily on just five grains and five animals.

Yet Tasmanian agronomist Dr Bruce French has established there are at least 30,000 edible plant species in our world.

So we have barely begun to explore the Planet in terms of what is good to eat and grow.

Many edible plants which don't feature in the modern diet are eaten by indigenous people – but this knowledge is local, fragile and may soon be lost.

Most of these plants are vegetables – and vegetables can be produced far more quickly, using less soil, water, energy, carbon and fertiliser than other foods.

They offer exceptional health benefits – preventing and even curing the chronic diseases which are killing us.

Intensively-produced fruits and vegetables in boundless diversity will form the mainstay of the future global diet.

They will create new industries and jobs. They offer huge potential for the urban food producer of the future.

Slide 27: green cities

'Green cities', alive with vegetation, fresh food, birds and insects, will replace the polluted, soulless, windy, concrete-and-glass urbanscapes of today.

These cities will recycle *all* their water and organic waste back into sustainable food production.

Their food supply will be climate-proof – unaffected by the shocks that hammer traditional broadacre out-door farming.

They will ensure a highly-diverse *local* food supply that never fails.

By mid-century, with the right investment, urban production can supply *half the world's food*.

Slide 28. Aquaculture

Aquaculture already grows a third of the world's seafood – and is on track to quadruple by 2050.

This will yield a diet kinder to the planet, more resilient to climate, healthier and more delicious for the consumer, more diverse and rewarding for the producer and the chef, and less costly to taxpayers.

World aquaculture now produces 70 million tonnes of fish and water plants (algae) a year. It will be producing 200 million tonnes by the mid-century and, with warming oceans, Tasmania will be at the forefront.

But where is the feed for these huge new livestock industries to come from?

Slide 29: algaepreneurs

The answer is from algae – the fast-emerging industry of water cropping.

In future huge farms of macro- and micro-algae will produce food for people, feed for fish and other animals including cattle, fuel for transport, pharmaceuticals, plastics, textiles and fine chemicals.

They will in turn be nourished on the flood of organic waste from the world's cities.

Thirty countries are already investing in what could become the world's largest irrigation industry.

Algae can be farmed in tanks or ponds on wasteland, in salt lakes, in shipping containers, in floating rafts and plastic bags in the ocean.

They are resilient to climate change. They can be integrated into urban food production, used to cleanse wastewater and harvest nutrients.

The world has 72,000 species of water plants [xlii], many containing valuable things like omega-3 oils and betacarotene which are essential to a healthy diet.

They can be made into delicious, healthy and sustainable foods as readily as any land-based crop.

Biofuels from algae can meet the world's entire transport fuel needs from an area slightly smaller than Tasmania and cut greenhouse emissions by 20 per cent.

This green, renewable fuel solution can ensure our future food system never lacks for energy.

Slide 30: robofarms

Traditional farms will still supply a third of more of the world's food.

They will be regenerative eco-farms, avoiding chemicals, recycling water and nutrients, storing carbon and protecting wildlife and wilderness.

Many will be planned and managed by artificial intelligence and worked by robots and drones.

They will produce elite quality health foods.

And this will give farmers a far better price for the sustainable food they grow than they get for today's "commodities".

Slide 31: re-wilding

Growing a third of our food in cities and another third in the oceans will bring immense relief to the stress on the world's soils, water, wildlife and rural communities.

For the first time, humanity will be able to feed itself without plundering the natural world.

This will pave the way for the regeneration of grasslands, forests, rural landscapes and communities, the re-wilding[xliii] of half the Earth and the recovery of its imperilled wildlife as EO Wilson has proposed.

Instead of throwing farmers off their land, society will begin to pay them as Stewards of the Earth – as well as producers of high value, sustainable eco-food.

This new approach to food production will enable humanity to end the 6th Extinction.[xliv]

Slide 32: year of food.

Finally, we cannot have a healthy, sustainable food system unless we have consumers who can make the right choices for themselves – and for the Earth.

It is their dollar signals that make all this happen – or else destroy the planet.

So we need one full year – a food year – in every junior school on the planet, to teach today's young citizens a new respect for food.

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, enjoyably, healthily and sustainably.

Teaching food is acceptable to all cultures, races, creeds and nations.

The means already exist to share these ideas universally. It is already starting to happen. We must make it go faster.

Slide 33: Age of food

Just as the 70s were the age of music, the 90s the age of the internet, we are entering the Age of Food.

Never has world cuisine been so spectacularly diverse – or so far short of its true potential.

Never have the opportunities been so many or so great.

Tasmania has the skills in crops, livestock, horticulture, aquaculture, sustainability, water, waste, and management to be a world leader in the global food revolution.

Farm advisers will be food advisers, pioneers of the Age of Food, its sustainable production systems and novel diets.

They will help build the 'ideas economy' and end the Sixth Extinction.

Food is one of the most creative acts which we humans perform.

How well we do it will define the future of our civilisation, now and for all time.

Slide 35: Food or War

*Julian Cribb is an Australian science and agriculture writer. He is author of *The Coming Famine: the global food crisis and what we can do to avoid it (UCP 2010)* and *Poisoned Planet* (A&U 2014). His third book in his trilogy on the human future is *Surviving the C21st* (Springer 2016) and explores how humans can overcome the existential threats we face. His forthcoming book *Food or War* will look at the nexus between food and conflict and the future of food.

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