Achieving global food security: Building a new food system where nutrition, climate change and sustainability collide

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Abstract

We stand at the confluence of three of the greatest challenges that humanity faces in the 21st century: achieving global food and nutrition security; climate change; and agriculture's environmental footprint. A business-as-usual approach to agriculture will not effectively address these challenges and feed and nourish the world's growing population while protecting the planet. Only an integrated holistic approach that preserves vital natural resources such as water, land, forests and fisheries will enable us to achieve our development goals. At the heart of this solution is 'climate-smart agriculture', which seeks to address challenges head-on by pursuing a triple win: sustainably increasing productivity; enhancing resilience and farmers' capacity to adapt; and reducing greenhouse gas emissions and increasing carbon storage. Climate-smart agriculture is at the heart of a paradigm shift in the food system and how we manage the fragile ecosystems that sustain rural livelihoods. It combines sustainable intensification – producing good quality food with fewer inputs – with a landscapes approach, so that progress on farms does not come at the expense of forests, streams, and biodiversity, the loss of which will have impacts on farmers' productivity and resilience down the line. Diverse farming systems also provide more diverse and nutritious diets. This will have to be accompanied by a reduction in food waste and significant changes in the nitrogen cycle. Capitalising on the potential of climate-smart agriculture requires broad, strategic partnerships and significant investment in research – particularly the global public goods that CGIAR and its partners may uniquely provide – to generate the scientific, political, financial and technological innovations needed to transform agriculture for the benefit of poor people and the planet.

This paper focuses on a fundamental and daunting challenge: how to nutritiously feed the world's growing population in uncertain times. To feed and nourish the 9 billion people who will be living on the planet by 2050, farmers will need to produce as much food as they have over the past 8000 years, and do so without destroying or taking a hefty toll on the environment.

Yet we are already failing to feed today's population. One in eight people suffers from chronic hunger, and more than a billion people – the majority women and

children – are undernourished. Most of these people live in Africa and South Asia, two regions of the world that are particularly vulnerable to the impacts of climate change, and urbanising at an unprecedented rate.

Hunger exacts a terrible toll. When a child is hungry or malnourished, their physical and mental development are stunted. Their ability to learn is compromised, and those who survive face a life of diminished earnings and productivity. This creates the vicious cycle of poverty that extends from generation to generation, preventing not only people but countries from realising their true potential.

Increasingly, all forms of malnutrition, from stunting to obesity, demand our attention.

We tend to think of obesity as a rich-country problem, but according to the Food and Agriculture Organization of the United Nations (FAO) the number of overweight and obese people in developing countries – 904 million – has more than tripled since 1980 and has now overtaken the number of malnourished – 842 million (Stevens *et al*. 2012). A study published in *The Lancet* in August 2014 found that one-third of the world's population is now overweight or obese, and 62% of these individuals live in developing countries (Ng *et al.* 2014).

Meanwhile our cities are growing at breakneck speed. Each year, 70 million people move into urban areas in developing countries. In the space of 30 years, 2 billion people will move to urban areas in emerging economies, doubling the global urban population. Built-up urban areas will increase by 1.2 million square kilometres, which is nearly triple the global urban land area in 2000.

As urban people become increasingly affluent, their food preferences change rapidly. When incomes rise, people tend to eat more meat. In low and middle-income countries, meat consumption is projected to grow 75% from 2005 to 2050, reaching 30 kilograms per person per year.

This growing demand has major environmental consequences. For every 1 kilogram of change in demand for meat, up to 10 kilograms of additional feed is required, intensifying pressure on crop lands and forests, and increasing emissions. A CGIAR-funded study found that beef and dairy cattle account for 77% of all global greenhouse gas emissions from livestock, but animals in the developing world require more food to produce 1 kilogram of protein than do livestock in wealthy countries. And ruminants, such as sheep and goats, require up to five times more feed to produce 1 kilogram of protein as meat than as milk (Herrero *et al*. 2013). In Africa, where most livestock graze on marginal land and crop residues, feed efficiency is low and emission intensity is high. CGIAR research found that cattle foraging in arid areas can release the equivalent of 1000 kilograms of carbon for every kilogram of protein they produce, or 100 times the emission intensity recorded in parts of the developed world (Herrero *et al*. 2013).

This raises questions about how to balance food wants and needs with those of the environment, and how to balance individual choice with costs to the community.

At the same time as we must understand the shifts in demand for food, we must grapple with challenges in supply, namely the extraordinary levels of food waste in our broken food system.

As the World Bank Group's *Food Price Watch* pointed out in February 2014, the world loses or wastes one-quarter to one-third of all food produced for people (World Bank 2014). In North America and Europe, roughly 95–115 kilograms of food per person are wasted annually, compared with 6–11 kilograms per capita in Africa and in South and South East Asia (FAO 2011). In Africa, an information tracking system shows that 10–20% of grain is lost prior to processing, amounting to billions of dollars in terms of production value. If these losses and waste were avoided, 48 million people could consume more than enough calories to sustain them each day for a year (World Bank 2011).

There are many different reasons for the waste, but behind them all is a broken food system. A lack of roads, refrigeration and storage means a lot of food never makes it from the farm to the market. Perversities in business models, regulations and consumer appetites result in more waste between market and home. Prices, a culture of excess, and attitudes that reflect the fragility of our food system mean more waste at our family dinner table or favourite restaurant.

And last but not least, our food system must adapt to climate change – the threat intensifier – as well as reduce its own contributions to that threat. Climate change and its impacts, such as more frequent and severe heat, drought and floods, are expected to intensify, diminishing crop yields even more significantly than we are seeing today.

The latest science predicts that if we continue down the 'business as usual' path we will be living in a 2°C warmer world by the 2030s, and that agricultural productivity will drop even further as weather patterns become more extreme. Globally, cereal yields could decrease by one-fifth. In Africa, the most food-insecure region of the world, farmers' yields could decrease by up to 50%. In a 4°C warmer world, currently predicted by the end of the century, over 10% of South Asia's agricultural land is projected to be flooded, with a 10% intensification of storm surges and a 1-metre rise in sea level (World Bank 2013a).

Warming and acidification threaten our ocean resources and fish stocks and livelihoods, especially in the developing world where more than 1 billion people depend on fish for most of their animal protein (World Bank 2013b). Over 700 million people rely on aquatic agricultural systems for their income (CGIAR n.d.). Many of these poor farmers, fishers and herders live in coastal zones and along river floodplains, making them vulnerable to sea level rise and extreme weather events. In South East Asia alone, about 138 million people live on coasts and within 30 kilometres of a coral reef.

The challenges – from waste to warming – spurred on by a growing population with a rising middle-class hungry for meat, are leading us down a dangerous path. Unless we chart a new course, we will find ourselves staring volatility and disruption in the food system in the face, not in 2050, not in 2040, but potentially within the next decade. A business-as-usual approach to agriculture

is no longer an option. It will not enable us to feed and nourish the world's growing population, nor to protect the planet.

To chart a new course we first need to face the fact that agriculture and land-use change are responsible for 30% of greenhouse gas emissions. They have to move from being a part of the problem to the core of the solution.

That does not mean that mitigation should come at the expense of production. In fact, I am suggesting the opposite. I am talking about increased efficiency leading to lower emissions per calorie or kilogram of food.

It is time for a shift in our approach to agriculture. We need to move to an integrated holistic approach that enables us to build a new food system where nutrition, climate change and sustainability come together and feed an increasingly urbanised population.

At the heart of this solution is what we term 'climate-smart agriculture' – an approach that refutes the idea that preserving vital natural resources, reducing carbon emissions and nourishing people is a zero-sum game. It offers farmers a future, a path through uncertainty. Climate-smart agriculture offers a triple win: increased productivity, improved resilience and greater climate change mitigation.

What does a triple win mean in practice?

- First, sustainably increasing productivity means increasing food and nutrition security by producing more food in ways that do not come at the expense of the environment.
- Second, enhancing resilience means reducing farmers' exposure to short-term risks and shocks, such as drought, pests and disease; improving the capacity of smallholder farmers to adapt in the face of longer term stresses such as shortened seasons and erratic weather; and building healthy ecosystems.
- Third, lowering agriculture's footprint means reducing greenhouse gas emissions for each calorie or kilogram produced; avoiding deforestation from agriculture; and increasing carbon storage.

Climate-smart agriculture combines sustainable intensification – producing more and better food with fewer resources – with a landscape approach, so that progress on farms does not come at the expense of forests, streams, and biodiversity, the loss of which will have impacts on farmers' productivity and resilience down the line.

The reality is, if we continue to fund crop expansion on the one hand, and natural resources conservation on the other, outside of a landscape approach, we will cancel ourselves out.

In Uganda, farmers are practising climate-smart agriculture by intercropping two key cash crops: banana and coffee. Banana captures atmospheric carbon dioxide, enriching soil carbon stocks while mitigating climate change; and its permanent canopy, roots and mulch prevent soil erosion and degradation. Research by CGIAR's International Institute for Tropical Agriculture (IITA) shows that shade

from the taller banana trees could cool coffee plants by at least 2°C – a huge plus in a warmer world. And by intercropping, farmers can earn significantly more income (IITA 2009, 2012).

This poses major challenges to the research community: in how we conduct research, what we research, who carries out the research, and the levels of committed funding. After falling behind the curve, siloed in crop-based research, we now see partnerships asking different questions and clearly focused on the cross-cutting challenges posed by population demands, nutrition needs, climate challenges, environmental limits and urbanisation.

A case in point is rice, which feeds almost half the world's population. Some 65% of the world's rice is produced in the great deltas of Asia, where one hectare currently provides food for 27 people. By 2050, one hectare, which will be massively affected if sea levels rise as the planet heats up, will need to support at least 43 people (Wilson 2014). It is an impossible task with existing rice varieties. It is an impossible context outside an effort to manage whole water basins differently, and aggressively move to reduce emissions.

That is why some of the best scientific minds in the world, including scientists from the Australian National University, CSIRO and CGIAR's International Rice Research Institute, are trying to convert the 3-carbon (C3) metabolic pathway of photosynthesis in rice into a 4-carbon or C4 pathway, so the plant can absorb sunlight faster. The C4 pathway, incidentally, was first discovered here in Australia by a CSIRO scientist. If researchers succeed in turbocharging the plant's engine, the new rice variety would need less water and fertiliser but yield 50% more grain than the best current varieties (Sheehy and Mitchell 2013).

Climate-smart agriculture is also about resilience, helping poor and vulnerable people cope with the negative effects of climate change and weather-related stress.

In Bangladesh, where over 20 million people suffer from malnutrition and nearly one-third of the population is living in poverty, CGIAR's WorldFish Center is helping women produce their own food by transforming unused ponds into fish farms (WorldFish n.d.). This dramatically increases food security, nutrition, and incomes.

This initiative highlights the importance of providing women with equal access to critical resources, technology and knowledge. Women make up 43% of the world's agricultural workforce (World Bank 2012). Yet women farmers tend to have smaller plots with poorer soils, insecure rights to land, and significantly less access to fertiliser, improved seed, credit, and other tools to gain more from the land. They are more vulnerable to climate change and natural hazards, and are less able to adapt.

It is estimated that giving ALL farmers equal access to productive resources could increase agricultural output in developing countries by as much as 2.5–4% (World Bank 2012).

In 'climate-smart villages' – sites in Africa and Asia where researchers, development partners, and farmers come together to test agricultural

innovations – CGIAR and its partners are empowering women to adopt climate-smart technologies and practices. And they are succeeding (CCAFS 2013, 2014).

We have seen the partnership yield important impacts. CGIAR and ACIAR, for example, have collaborated with developing country scientists to reduce poverty and hunger (Page 2009), including by:

- developing and disseminating improved crop varieties in East Timor and Iraq,
- boosting fishing productivity in the Pacific, and
- improving agricultural practices in southern Africa.

Last year, Australia and other dedicated investors helped CGIAR reach a major milestone: doubling annual funding to US$1 billion. It is money that has helped millions of farmers and consumers avoid hunger and poverty.

We need to capitalise on the vast potential of agricultural research, so CGIAR has set another ambitious goal: doubling our funding again, this time to US$2 billion by 2020.

I would like to leave you today with an invitation to join us in pursuit of this goal. It is vital. The stakes are high.

As Lloyd's of London, the insurance giant, makes clear in its report 'Feast or Famine', food insecurity will be one of the greatest risks to global society over the next 10 years (Lloyd's 2013). Whether big business, small farmer, or government policy maker, we all need to take responsibility for creating a food system that is climate-smart, people-focused and planet friendly. The world's future security is at stake.

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