How does agriculture respond to the nutrition challenge?

Professor Andrew Campbell
Australian Centre for International Agricultural Research (ACIAR)

Abstract

Good question! In the 'good old days' of agricultural research from the middle of last century, the objective was clear – increase food and fibre production to feed and clothe rapidly growing human populations. That is no longer the case. Agricultural research and policy now confront new challenges of unprecedented scale and complexity: climate change and nutrition. With fewer than one-third of the global population on a healthy diet, what is the role of agriculture? It is no longer just about producing more food, more efficiently and more sustainably, but producing more and healthier food, efficiently and sustainably, and ensuring that it is distributed equitably. Systemically, agriculture is obviously part of the food system, but it is also central to the health system, with climate change as a risk multiplier for both. Agriculture and health have yet to come to grips with this 21st Century reality, in either science or policy. This brief overview presentation discusses this dilemma through the lens of agricultural research. We are still shaping the research agenda for nutrition in agriculture. It is clear that we will need to develop new platforms for collaboration across the food system, between the food and health systems, and between the public and private sectors. In doing so, the skills we have developed in brokering durable partnerships, the practice of involving end-users in the process of scientific inquiry, and the principle of developing enduring capabilities in science and policy in the countries with which we partner, remain more relevant than ever.

The title of my talk is a daunting question and my short answer is: 'With difficulty!'. If this was straightforward we would have sorted it out by now. The context of the nutrition challenge has just been presented clearly by Sandro Demaio and Jessica Fanzo. My overview now zooms in on agricultural science and research.

We have seen the numbers in Figure 1 before. It does not matter how many times we see them, though, because we need to internalise them as some of the framing context for agricultural science this century. Suffice it to say that over the last 150 years or so agricultural science has shown that it can respond to very big challenges very effectively. We have done it before and I am sure we can do it again. But we are not going to succeed with the same paradigm that has brought us to where we are now.

Consider the differences between an agricultural production paradigm and a food systems paradigm: obviously there are very many more people involved

This paper has been prepared from a transcript and the illustrative slides of the presentation.

Figure 1. The nutrition challenge.

– upstream, the 570 million farmers, and downstream the 7.6 billion (rising to 9 billion) consumers.

Humans now have geological-scale influence on the Earth. This epoch is therefore now known as the Anthropocene, but even in the Anthropocene the single biggest lever we have in our hands is agriculture. Agriculture employs more people than any other sector; it uses most of the world's water; it is on track to be the biggest global emitter of greenhouse gases (as a food system rather than just on-farm); it is certainly out of whack with the nitrogen cycle; it uses most of the land; it is the biggest driver of land-clearing; and so on. Agriculture is also easily the most effective way to lift people out of poverty, and that has been proven again and again. So agriculture has both the yin and the yang. It is a big powerful lever, with more power to do good than anything else.

The pivotal role of agricultural research

Nutrition has three dimensions: availability, access and utilisation. Agricultural science has clearly been making food 'available' for a long time and we have been spectacularly successful in terms of quantity. Nevertheless, as Fanzo and Demaio have already pointed out in this conference, there are some adjustments required on the quality side. There is already a 'menu' there – a research agenda – in each of those areas.

Agricultural science also has a very important role in improving access because, amazingly, many of those 570 million farmers do not have enough to eat, or they have an inappropriate diet. It seems crazy to think that the people producing our food are themselves often suffering from poor diets. As Jessica Fanzo said earlier, supply can shape demand, but in my opinion agriculture's role on the demand side of the equation is modest. However, we do need to be working closely with our colleagues in public health and similar disciplines.

Figure 2 is another way of looking at some of the information Sandro Demaio presented earlier today. It compares the Harvard Healthy Eating Plate model (left-hand side) with the proportions of food types being produced by agriculture, at least in 2011 (right-hand side). Clearly those two do not match: for example, humans should be eating about half our diet as fruits and vegetables, yet those commodities are about 10% of what agriculture is producing.

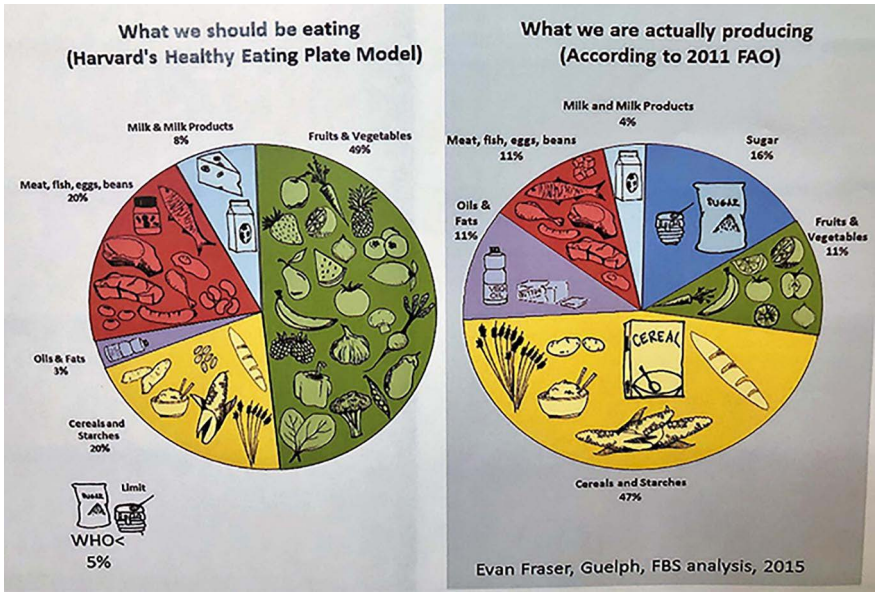

Figure 2. Proportions of food types in an ideal human diet (left) compared to proportions of those food types being produced globally.

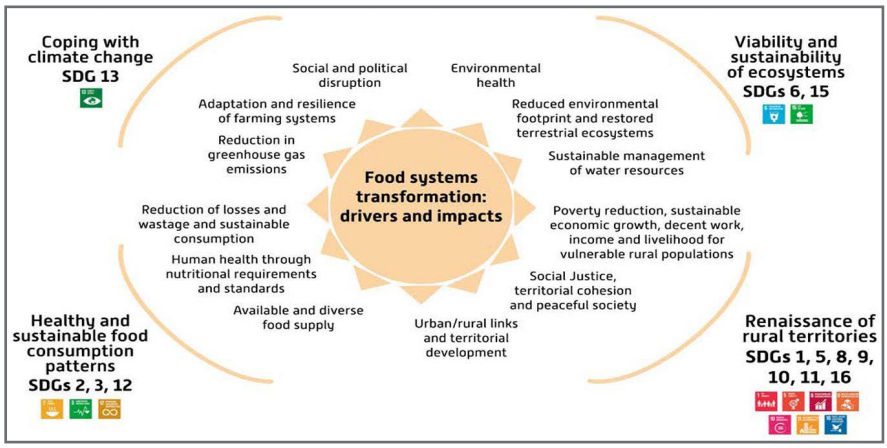

Figure 3. Food systems are central to meeting the Sustainable Development Goals (Caron *et al.* 2018).

A paper just published by Patrick Caron and others, including several people from the CGIAR System, has made the same point as Jessica Fanzo did, summarised in Figure 3 above. The key point is that the food system is fundamental for many of the Sustainable Development Goals. The 'footprint' of agriculture is so big that the agenda for global thinking must include rural communities, rural territories and rural societies, which as a whole occupy a big chunk of the planet. We need to be thinking about that from the perspective of broader development.

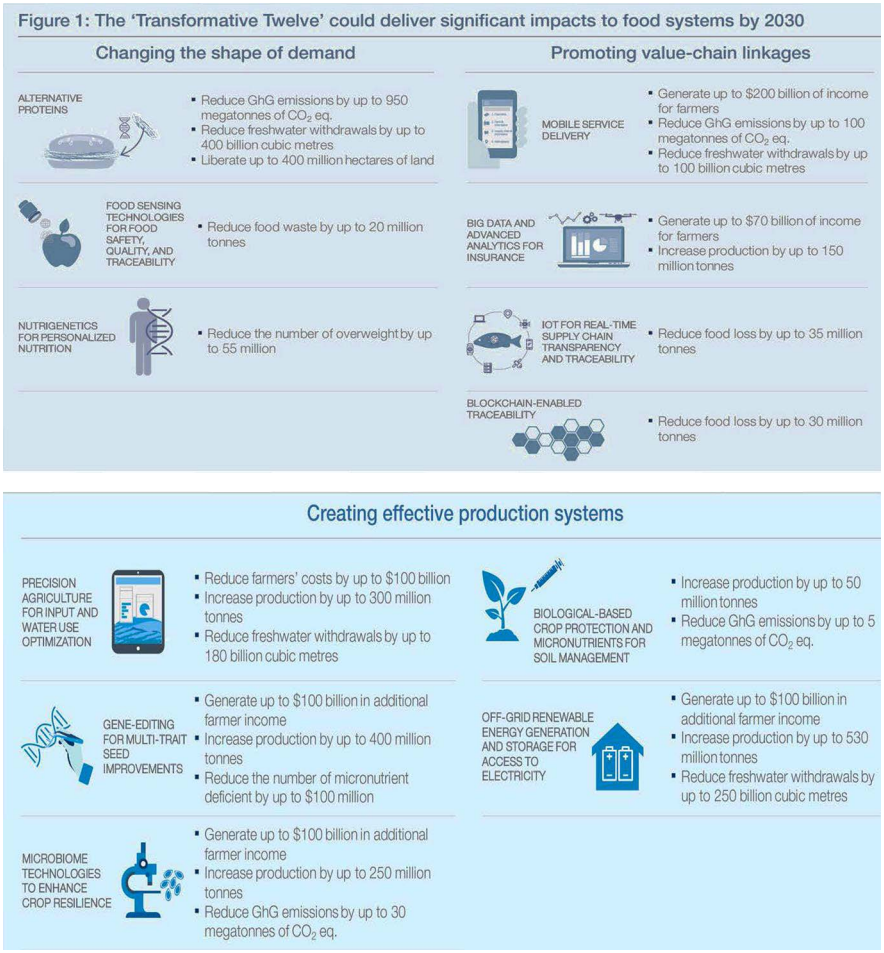

Figure 4. The Fourth Industrial Revolution: high-tech silver bullets for healthy, efficient and sustainable food systems? (World Economic Forum 2018).

There is also range of technological solutions that makes the future extremely exciting. The World Economic Forum has put out a report looking at new and emerging technologies that can make a big difference – from alternative proteins to mobile service delivery (Figure 4). The penetration of the digital technologies is enormous, even in low income countries. For example, we were in the field in Myanmar recently and saw that farmers there are using multiple mobile phones, even in relatively remote and under-resourced areas.

Taken together, this is an exciting suite of technologies. Agriculture needs to be an energy producer via off-grid renewable energy generation, not just an energy consumer and purchaser. Big data, blockchain-enabled traceability, nutrigenetics, precision agriculture, gene-editing, microbiome technologies, biologically-based crop protection and micronutrients, and there are really interesting ways of using genetic modification to manipulate the characteristics of plants so that they are much more efficient as energy producers as well as

food producers. There is an appealing convergence here, and I think for the young scientists in the audience in particular, the coming decades are going to be at least as stimulating as the amazing years after the Second World War.

However, although the technological agenda in agriculture is at the 'sharp end' of innovation, it will not solve the need to make the human population healthier, nor influence societal choices.

Implications for agricultural science

Until now, too often agricultural scientists have tended to think of multidisciplinary teams as maybe comprising an agronomist and economist and a farming systems modeller. Now we need to think also about how agriculture links to public health. We need to work with sectors that we are not used to working with, such as nutrition, ICT and finance – in other words, reconceiving multidisciplinarity in much broader terms.

In my mental model, 'trans-disciplinarity' is different: it is when you have the end-users of the research involved in the inquiry process, and that is an absolute must in this agenda. We must have the various players in the food system involved in the process of discovery and developing solutions. There will need to be new collaborations, right across the system – including with the financial sector, with global agribusiness firms, and so on. I have been very encouraged by discussions in recent weeks with firms that do millions of transactions per day with smallholder farmers around the world. That first mile from the farm into the food system is where these firms feel they need much better data, and that is where I think there is a natural synergy between their activities and those of agricultural scientists. At scale, they can interact with farmers far better than we can.

We are under-investing in agricultural research given the size of the sector. Agriculture represents about 5% of global GDP in primary production, or 30% of global GDP over the whole food system. Yet the agricultural science sector gets only about 5% of global R&D funding, about US$70 billion, and less than US$1 billion of that goes to the CGIAR System, so while the CG System might have the biggest network and structure in international agricultural research it still receives a small portion of the global expenditure. Therefore, it is crucial that we think about how to make the whole system work better, not just the CGIAR.

My colleague Dr Jürgen Voegele, the Chair of the System Council of the CGIAR and Director of Agriculture for the World Bank, makes the point that at the moment the world is spending about US$550 billion per year on agricultural subsidies, many of which are making these problems worse. If we could arrange to have, say, 1% of that expenditure redirected into R&D via the CGIAR, we could really make a difference on some of these issues. To do that will mean forming new coalitions of investors: the global health research sector is far better at mobilising large funds than the agricultural research sector. We need to learn from their tactics in mobilising resources.

ACIAR projects that are making a difference

In July and August of this year I have been in Tibet, Bangladesh and the Philippines. The photo on the previous page was taken 'on the roof of the world', 5000 m above sea level, on the Tibetan Plateau, the water column of Asia, the watershed for 13 of the great rivers of Asia that water over half the world's population. Agriculture and agricultural research are shaping that watershed.

The photo above (this page) is of the Chocolate Hills of Bohol, in the conflict-vulnerable southern Philippines. This is a farm where, 20 years ago, the farming system was cassava grown by ploughing up and down the hill. Soil losses were 50–300 t/ha/year. Yields were declining by 500 kg/ha/year. The main irrigation dam was filling up at such a rate that the engineers gave it a useful-life-expectancy of less than 40 years. ACIAR and ICRAF (the World Agroforestry Centre), applying landcare techniques from Australia, have persuaded the farmers to change from growing cassava up and down the slope to growing mixed vegetables on the contours and perennial plants on permanent vegetation strips.

As a result, this particular farmer's income for this cropping season was 9000 Philippine pesos per week, equivalent to A$230 per week. He has extended his house and paid for his son to go through university, graduating as a professional forester. Sedimentation in the dam is now negligible, and poverty rates in the municipality are a quarter of what they were. This fourth-tier municipality won a National Nutrition award in the Philippines last year – 'fourth tier' meaning one of the poorest categories of municipalities in the Philippines.

The photo immediately above is of a project ACIAR is funding in Kenya with our sister organisation the Canadian International Development Research Centre (IDRC). In the big slums on the edge of Nairobi, young German and French environmental engineers have developed a new composting-toilet system. In the slums every morning the human waste is collected and used to grow black soldier flies, which multiply their biomass by a factor of a hundred in three weeks. They produce enormous maggots (top right of photo) that are then boiled and sundried and make excellent chicken food. The village chickens lay their eggs for much longer, the eggs are much higher in micronutrients, the waste material (bottom right of photo) is turned into high quality organic fertiliser and the residue is turned into bioenergy that goes back into the grid. The whole plant operates on 1 ha of land, needs no extra water, no extra energy, and is greatly improving food security.

Industrial ecology on the edges of our big cities, improving food security, water, sanitation, human health and nutrition – that is the sort of joined-up work we must be aiming for now, rather than simply trying to lift monoculture crop yields. Bigger yields are still important but they are now a tiny part of the picture.

These are just a handful of ACIAR's 200 or so applied research projects across the Indo-Pacific region, working in close partnership with scientists from the low- and middle-income countries in which we operate. The ACIAR website has more information.

Summary

We are not going to achieve these new goals unless we have a revolution in governance (see box below). Humans are now operating at a scale we have never operated at before and we are physically changing the planet and exceeding some boundaries already. Many of the changes we are going to confront will be unpredictable. Surprises are inevitable, and so we are going to have to respond at a range of levels.

Governance for the Anthropocene

- Humans are now changing the basic biogeochemical cycles of the planet.
- Exceeding some planetary boundaries already.
- On-going environmental change will challenge governments, industries and communities.
- Many responses need to be designed or interpreted at regional and local levels.
- Durable implementation depends on community support and engagement.
- Policy convergence in food, nutrition, water and health systems (risks amplified by climate change) requires integrated planning & delivery, & decentralised leadership and decision-making.
- Resilience theory warns us to look at scales above & below – need to equate the local & the global.

This means agricultural scientists and policy makers need to have the support of the general community, and that means we must use much more participatory processes than ever before.

To more effectively manage the big convergence of food, nutrition, water and health, amplified by climate change, we need to apply a much more integrated approach than we have ever used in the past. For resilience, we know it is not good enough to just focus at one scale; we need to be able to look at the scales above and the scales below the immediate focus of concern, to produce durable responses.

Global agriculture has two very big framing challenges to face. Nutrition security, along with climate change, is the mega-challenge for agriculture and agricultural and food systems research, this century. How we respond to that – intellectually, organisationally, and in a governance sense – will determine how comfortable this planet is to live on for coming generations.

References

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Andrew is Chief Executive Officer of the Australian Centre for International Agricultural Research (ACIAR). Through a series of influential national roles, Andrew has been at the leading edge of sustainable agriculture and natural resource management science and policy in Australia for more than 30 years. He has long been recognised for his visionary work on the relationship between people and land, firstly in developing the concept of whole farm planning, and then through Landcare, as Australia's first National Landcare Facilitator. Andrew was previously Director of the Research Institute for the Environment and Livelihoods (RIEL) at Charles Darwin University, CEO of Land & Water Australia, Managing Director of Triple Helix Consulting, and Senior Executive in the Australian Government environment portfolio. He is an honorary Professorial Fellow at Charles Darwin University and at the Australian National University's Fenner School. Andrew has written widely on landcare, knowledge management and sustainability issues for policy, science and general audiences. With training in forestry, rural sociology and knowledge systems from the University of Melbourne, and Wageningen Agricultural University in The Netherlands, his research interests (reflected in more than 100 publications) span the interactions between climate, water, energy and agrifood systems, and the interface between knowledge, science and policy. Andrew maintains an involvement in his family farm (forestry, cropping and sheep) in western Victoria, where his family has been farming since the 1860s.