



The Future of Food

The massive increase in the human population that has occurred over the last century is precipitating a cascade of environmental, economic, political and cultural changes that have far-reaching implications for the provision of an adequate global food supply.

The Global Challenge

Food is fundamental for human existence and health but many of the world's inhabitants experience ongoing hunger. For some this is due to drought, others war and for many it is a lack of money to buy food. The United Nations, Food and Agriculture Organization estimates that 850 million people worldwide are hungry and a greater number suffer from nutrient deficiencies. Approximately one billion people have inadequate nutrient intake, others excessive calorie intake. Obesity has become an epidemic in developed countries, while in some developing societies the double burden of nutrient deficiency and obesity is apparent. The challenge of preventing hunger and malnutrition will become even greater as the global population grows from the current 7 billion people to nearly 10 billion by 2050.

Not only is the global population increasing, we are living longer and becoming more affluent. As incomes increase, diets become more energy-dense and meat becomes a larger proportion of the diet. These changes in population and cuisine have led to a tremendous rise in the demand for animal-source protein. The competition between livestock and humans for grains and other

high quality plant foods, whether real or perceived, is recognised as a major challenge. This has become more complicated with the diversion of grain to the production of biofuel.

For many years there has been an ongoing debate about the benefit or otherwise of animal-source foods, especially red meat consumption. In the past, claims of the detrimental effect of animal-sourced foods on human health have been made without rigorous scientific investigation. There is no doubt, however, that animal source foods, including lean meat, fish, poultry, eggs and milk, are an excellent source of protein and micronutrients. Fish can be added to this list but wild fisheries are rapidly being depleted. It should not be forgotten that humans evolved as 'meat eaters'. It is unlikely that we will lose our appetite for meat but we must curb it. In many instances, the mechanism that allows impoverished families to improve their income and wellbeing is access to livestock or poultry.

Whatever diet we choose in the future our food will need to be produced more efficiently. Increased agricultural productivity must come from a reduced land area and

Increasing Competition for Grains

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More Efficient Production

Our food will need to be produced more efficient. Increased agricultural productivity must come from a reduced land area and resource base.

Benefits from Globalisation

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resource base. Arable land continues to be lost due to soil degradation and urbanisation. We will need to be less dependent on resources that are becoming scarce, like arable land and water, or more costly, like energy and petrochemical-based inputs, including fertilizers. Some would argue that it is how we manage the nexus between food, water and energy that is our biggest challenge for global food security.

Conversely, the environmental impact of agriculture should not be forgotten. There is no doubt that agriculture exerts considerable pressure on water supplies, especially when irrigation is used. What form of energy will agriculture use in the future to produce, process and transport our food? The impact of agriculture on plant and animal biodiversity and other ecosystem services also must be addressed. Pollination of crops by bees is an integral component of agricultural production. Any disruption to this ecosystem service could have devastating consequences for food production.

Climate change will accentuate the challenges identified above. Pest and disease problems of plants and animals are likely to increase partly in response to climate change. Consensus exists regarding impacts of agricultural production, processing and distribution of food on global climate change. A significant proportion of anthropogenic emissions of greenhouse gasses come from agriculture and these emissions need to be reduced.

Just as the climate system is global, so is our food system. While globalisation may create opportunities and increase food distribution the benefits predominantly flow to those with a developed and secure food supply. Government subsidies, import restrictions and food safety legislation all mitigate against an equitable distribution and pricing of food. In some situations this will lead to civil unrest.

Options and Possibilities

Second Green Revolution

Another "Green Revolution" is required but today's revolution must be different to overcome existing environmental, financial and societal constraints. It is no longer possible or responsible to use unlimited water and chemical inputs to increase production.

In developing countries where many of the population exist as subsistence farmers the food system is relatively straight forward. In contrast to developed economies where the food system or agricultural supply chain includes all aspects of crop and animal production, aquaculture, processing, storage, and distribution of food products through the wholesale and retail systems. More opportunities exist to guard against adversity and to increase productivity when the food system is complex and not reliant on a few food staples.

Food production must increase substantially but over the next decade both systems must cope with more severe climate events (2014 was the hottest year on record) and increased globalisation as more free trade agreements are signed. The increased amount of food required will need to be produced with finite water supplies on existing areas of arable land. There is general agreement that another

"Green Revolution" is required but today's revolution must be different to overcome existing environmental, financial and societal constraints. It is no longer possible or responsible to use unlimited water and chemical inputs to increase production. Other approaches to food production and processing must be found that use existing and new technologies in conjunction with appropriate social policies that are sustainable. Policies must ensure conservation of global biodiversity and animal welfare. The Commission on Sustainable Agriculture and Climate Change identified seven critical areas for the transition to a sustainable global food system;

1. Integrate food security and sustainable agriculture into global and national policies
2. Significantly raise the level of global investment in sustainable agriculture and food systems in the next decade

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3. Sustainably intensify agricultural production while reducing greenhouse gas emissions and other negative environmental impacts of agriculture
4. Develop specific programs and policies to assist populations and sectors that are most vulnerable to climate changes and food insecurity
5. Reshape food access and consumption patterns to ensure basic nutritional needs are met and to foster healthy and sustainable eating patterns worldwide
6. Reduce loss and waste in food systems, targeting infrastructure, farming practices, processing, distribution and household habits
7. Create comprehensive, shared, integrated information systems that encompass human and ecological dimensions

We must achieve all of these goals. Future food production must have both vastly increased productivity and good environmental practices. Meeting these goals will require the effective use of science. Biotechnology with its evolving “omics” tools (genomics, proteomics, metabolomics), will allow the development of new approaches to counter some of the complex problems we now face. With these approaches it will be possible to fast track current crop plants with agronomic traits such as yield and tolerance to environmental stress using the same or diminished inputs and be able to withstand pathogen attack and potential contamination with mycotoxins. The coming generation of crop plants may have value-added outputs such as improved nutrient and food functionality and be sources for biomass for biofuel production and human therapeutics. Another important area that will undergo

a major renaissance is microbial ecology with the application of molecular biology techniques. While microbial ecology is not a new concept, it is pivotal to understanding the presence and functioning of microbes in complex and dynamic food environments, both outside and inside the gastrointestinal tract. As we understand more about the complex and dynamic microbial ecology of foods, we will be in a better position to manipulate those biotic and abiotic factors that enhance food quality and human health. Similar improvements will be made to animal health and it is the unique microbial ecology of ruminant livestock (cattle and sheep) that allows them to convert human-inedible plant feeds and by-products into nutritious human foods.

The other platform that should permit a major leap forward is nanotechnology. It holds promise for responding to the need for more precise management of resources such as water and fertilizers, improving crop and livestock production, controlling pests, diseases, and weeds, monitoring plant disease and environmental stresses, improving postharvest technology, including waste management and food safety. It will allow the application of precision agriculture in both developed and developing economies.

However, without consumer acceptance, new technologies will not succeed. This will require education and communication of the benefits that will accrue from their application. This will need to be achieved with a back-drop of increased consumer interest in foods produced locally and organic agriculture. These “feel-good” approaches to agriculture will not overcome the food demands of the future but the more useful aspects of these practices must be part of food production in the future.

Proposed Way Forward

Despite daunting challenges, the application of contemporary food production and processing practices along with scientific advances combined with appropriate social

policies can underpin sustainable food production systems. Clearly, the solution to the challenge of meeting future food demands lies in increased agricultural

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Investment in Innovation

There has been a global decline in agricultural R&D in the past four decades. There is now an urgent need to redouble the agricultural research effort. The new food producing system has to be science-based with low resource input.

Education and Economics

In developed economies, education will be equally important as consumer attitudes will be very important to the eventual acceptance of new technologies and adoption of different patterns of food consumption. Part of the economic equation must be to pay farmers more for their products.

Sustainable Consumption

Part of the solution to feeding the planet is the development of consumption patterns that meet requirements in a safe, nutritious and affordable manner. In developed countries this will mean learning to eat sustainably with less reliance on meat.

Reducing Food Waste

Postharvest losses of plant foods can be substantial in developing countries and amount to 30 to 50% of production due to a lack of storage infrastructure. In developed countries we throw away a similar proportion of all food

productivity everywhere, but particularly among small-holder farmers, of whom there are millions worldwide. Mixed crop and livestock production systems produce about half of the world's food supply. Targeting these systems should be a priority for policies to sustainably intensify production by carefully managed inputs of fertilizer, water, and feed to minimize waste and environmental impact, supported by improved access to markets, new varieties, and technologies.

The global food system is extremely complex and the gap between developing and developed nations is not only in economics but also in science, governance, and public information. Thus, to tackle these issues, a number of areas must be addressed urgently:

- Science and research; There has been a global decline in agricultural R&D in the past four decades. There is now an urgent need to redouble the agricultural research effort. The new food producing system has to be science-based with low resource input. To ensure this occurs there must be definable career paths to encourage the next generation to enter agriculture and food research.
- Economics and education; Increased economic development is required in developing countries hand-in-hand with education. These improvements will ultimately decrease the birth rate. In many economies, women manage the food cycle and their recognition and education should be a priority. In developed economies, education will be equally important as consumer attitudes will be very important to the eventual acceptance
- of new technologies and adoption of different patterns of food consumption. Part of the economic equation must be to pay farmers more for their products.
- Sustainable diet; Part of the solution to feeding the planet is the development of consumption patterns that meet requirements in a safe, nutritious and affordable manner. In developed countries this will mean learning to eat sustainably with less reliance on meat. Through the application of the tools of molecular biotechnology, future nutrition will be personalised to account for individual variation and to improve health and well-being.
- Waste; Postharvest losses of plant foods can be substantial in developing countries and amount to 30 to 50 % of production due to a lack of storage infrastructure. In developed countries we throw away a similar proportion of all food produced. The combined loss would feed about 3 billion people. Reducing wastage will provide breathing space to allow the development and adoption of new food production technologies.
- Governance: Addressing these complex issues will take commitment and collaborative efforts at both an international and national government levels. It must also involve government agencies, private enterprise, and nongovernmental organizations. An atmosphere of collective good will ensure that research investment is appropriate and will enable the development of policy to allow integrated implementation of new food production systems.

Impacts and Implications

Over the next decade and beyond maintaining global food security will become much more difficult as the population increases. We must double food production in a sustainable manner. Greater quantities of food will need to be produced with reduced inputs of water, energy and nutrients on the

same or reduced area of arable land in a changing environment. To do otherwise will court significant human conflict.

The increasing urbanisation of the global community exacerbates this situation as more and more people become isolated

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from the land and farming. Moreover, urban populations are more vulnerable to disruptions in the food supply chain. City folk need to understand where their food comes from. This will require education that is starting to happen with the realisation that nutrition is an important component of human health. The nutrients supplied in our food reflects agricultural practises and food processing.

The link between human health and agriculture is through food; its sources, composition and distribution. Food sources include both plant and animal and the availability and composition of the latter is largely determined by the cost of plant-based feedstuffs. It is not surprising therefore, that any consideration of population demographics demonstrates the importance of agricultural production as a major determinant of public health. This would appear to be a straight forward proposition, embracing the adage 'we are what we eat',

especially in developing societies. However, the relationship between agricultural production and human health is complex in a modern, developed society and measuring the impacts is difficult.

Our relationship with food must change. We will need to reinvent our diets to meet our nutritional requirements for optimal health and in so doing consume fewer calories and less meat. To maintain a viable food supply we must be prepared to pay realistic prices and reduce waste throughout the food supply chain. All of the required changes must be underpinned by rigorous research. This will require substantial public and private sector investment.

Visionary public policy, both national and international, must be a major instrument if our food systems are to evolve in a sustainable manner.

Maintaining Global Food Security

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Reinventing Diets

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Lead Expert – Prof. Wayne Bryden

Foundation Chair in Animal Science at the University of Queensland.

Lead expert on the Future of Food.

Professor Bryden is the Foundation Chair in Animal Science at the University of Queensland. He was Head of the School of Animal Studies at the University of Queensland from 2002 to 2007 and prior to that appointment was Pro-Dean of the Faculty of Veterinary Science at the University of Sydney, where he was also Director of the Poultry Research Foundation. His research interests include nutrition of monogastric animals and nutritional toxicology of all domestic species and he is a registered Animal Nutritionist. He lectures in a range of subjects to both animal science and veterinary science students and has advised some 50 research higher degree students.



In 2003 he was awarded the Centenary Medal for his contributions to science and education, and in 2005 he co-chaired the Gordon Research Conference on Mycotoxins and Phycotoxins. He is currently a member of the WHO Expert Panel on Food Safety, President of the Australasian Equine Science Society and Editor-in-Chief of Animal Production Science.

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About Future Agenda

Context – Why Foresight?

In an increasingly interconnected, complex and uncertain world, many organisations are looking for a better understanding of how the future may unfold. To do this successfully, many companies, institutions and governments are working to improve their use of strategic foresight in order to anticipate emerging issues and prepare for new opportunities.

Experience shows that change often occurs at the intersection of different disciplines, industries or challenges. This means that views of the future that focus on one sector alone have limited relevance in today's world. In order to have real value, foresight needs to bring together multiple informed and

credible views of emerging change to form a coherent picture of the world ahead. The Future Agenda programme aims to do this by providing a global platform for collective thought and innovation discussions.

Get Involved

To discuss the future agenda programme and potential participation please contact:

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Future Agenda 1.0

The Future Agenda is the world's largest open foresight initiative. It was created in 2009 to bring together views on the future from many leading organizations. Building on expert perspectives that addressed everything from the future of health to the future of money, over 1500 organizations debated the big issues and emerging challenges for the next decade. Sponsored globally by Vodafone Group, this groundbreaking programme looked out ten years to the world in 2020 and connected CEOs and mayors with academics and students across 25 countries. Additional online interaction connected over 50,000 people from more than 145 countries who added their views to the mix. All output from these discussions was shared via the futureagenda.org website.

Future Agenda 2.0

The success of the first Future Agenda Programme stimulated several organizations to ask that it should be repeated. Therefore this second programme is running throughout 2015 looking at key changes in the world by 2025. Following a similar approach to the first project, Future Agenda 2.0 builds on the initial success and adds extra features, such as providing more workshops in more countries to gain an even wider input and enable regional differences to be explored. There is also a specific focus on the next generation including collaborating with educational organizations to engage future leaders. There is a more refined use of social networks to share insights and earlier link-ups with global media organizations to ensure wider engagement on the pivotal topics. In addition, rather than having a single global sponsor, this time multiple hosts are owning specific topics either globally or in their regions of interest. Run as a not for profit project, Future Agenda 2.0 is a major collaboration involving many leading, forward-thinking organisations around the world.

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