Towards an Affordable and Sustainable Food Supply—Recent Advances and Future Prospects[1]

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Looking to the future, the agrifood supply chain faces two grand challenges: feeding a growing population and ensuring that food is nutritious and healthy. These are grand challenges because of their complex, multifaceted natures, involving both demand- and supply-side drivers.

On August 31, 2017, ILSI SEAR Australasia, in conjunction with AACC International (AACCI) hosted a symposium, Towards an Affordable and Sustainable Food Supply—Recent Advances and Future Prospects, in Sydney, Australia, to discuss what these challenges mean and some innovative solutions.

New Agricultural Technologies and Sustainability

On the supply side, the rate of increases in crop improvements for production of food will not meet forecasted demand. Constraints on land, water, and other inputs, as well as evolving threats, including biosecurity, climate change, and social license, all create production challenges. Additionally, the right types of production and processing need to occur. Although many people around the world are undernourished, there are many who overeat. This is where supply melds with demand. Even if a sustainable, healthy, and tasty product is available, consumers need to want to eat it. Thus, solutions to these problems will require careful planning, collaboration, and integration across the supply chain among health officials, government agencies, researchers, industry, and consumers.

An obvious question in finding solutions to meet these challenges is what do consumers want? It turns out "authenticity" is the latest in a growing list of consumer demands. To be authentic, a product must be what it says it is. It must be safe, of high quality, and have integrity. The latter two aspects can refer to a broad range of things, including the technologies used to make a product, its origin, or its sustainability. To meet consumer demands, there must be a way to prove product qualities (e.g., traceability through the supply chain or certification).

As new technologies emerge on the farm, how they are regulated and represented to consumers will be critical to their profitability and success. Technologies that provide gains in yield may be at odds with desirable authenticity traits. Take for instance, genetically modified (GM) crops. When these crops entered the Australian supply chain two decades ago, regulators and consumers approached this new technology with caution. Responding to this concern, legislation was passed requiring premarket assessment and approval, as well as mandatory food labeling.

Today, even though 30 years of research has proven their safety, regulations and disapproving consumer sentiment still persist. This has generated additional costs up and down the supply chain—from the companies developing these crops who need to obtain approvals, to the certification systems put in place by logistics companies to sell and store GM and non-GM grains.

This scenario is why all eyes are on the regulators who are overseeing the new generation of breeding techniques. Lines are being blurred between the definitions of traditional and newer gene technology-based breeding techniques. CRISPR-Cas9, for example, can make single base-pair changes in DNA, with no foreign DNA inserted. There is no way to distinguish this manipulation from natural variation. Responding to this, Food Standards Australia New Zealand (FSANZ) and the Office of the Gene Technology Regulator (OGTR) are reviewing regulations with regard to what techniques require premarket approval and the definitions of gene technologies, as well as foods produced using such technologies.

It is impossible to predict how consumers will respond to new technologies. Researchers, industry, and government must learn from past technology introduction failures and ensure information is communicated effectively to the public.

Regardless of how consumers and regulators respond to new gene technologies, parallel opportunities exist. Traditional plant breeding techniques are producing impressive crop improvements. The Australian Commonwealth Scientific and Industrial Research Organisation (CSIRO) has recently developed a gluten-free, hull-less barley variety and a high-amylose wheat variety. Advances in breeding, including high-throughput screening, can reduce product development times drastically for new varieties. Additionally, novel "-omics" approaches and big data are helping to link genotype and phenotype to better understand plant genetics at a fundamental level.

Breeding technologies share a common goal to increase yield. However, pests, diseases, and weeds reduce actual yields by 40% (this increases to 60% when no crop protection product is used). Accordingly, achieving yields close to the potential maximum should be a top priority. The key to this is increased research

Sustainability meeting speakers (left to right): Anne Bridges (AACCI), David Guest (University of Sydney), Les Copeland (University of Sydney), Kay Khoo (Bayer CropScience), Mary Anne Augustin (CSIRO Agriculture & Food), Lisa Kelly (FSANZ), Steve Jobling (CSIRO), Paul Brent (University of Laval, Quebec, Canada, and ILSI).

[1] This report is adapted, with permission, from a report on the symposium hosted by ILSI SEA Region Australasia Country Committee and AACC International (http://ilsisea-region.org/event/sustainable-food-supply2017).

and development output and ensuring growers use best practices. One new practice that has emerged from digital agriculture is crop surveillance, whereby a grower can monitor crops for disease symptoms so they can be controlled more quickly. The success of such technologies will depend on access to information and grower support for their implementation. New practices may also provide opportunities to add value, if they can be marketed in ways that appeal to consumers (e.g., "greener" practices).

Food Processes and Improvements in Food Security

The postharvest supply chain suffers considerable losses as well. Food processing is an exciting area for development of new techniques to help minimize losses, while improving nutrition, maximizing resource use, and enhancing flavor. New technologies involving high pressure and microwave radiation are being used to create pre-made meals that don't require refrigeration. Other pressure-based techniques are being used to produce nutritious unpasteurized juices and potentially safe to drink raw milk. Fortification of milk with vitamin D and encapsulation of omega-3 fatty acids are two of the many examples of food processing techniques used to improve nutritional quality. Processing can also be used to optimize extraction and minimize waste (e.g., use of ultrasound technology to increase extraction of oil while minimizing water use).

Innovations also extend beyond the processing level. New technologies are providing consumers with access to more information than ever before. The new SmartLabel database allows consumers to search product information for things such as country of origin, allergen information, product claims, and traceability. Portable near-infrared technologies allow consumers to obtain real-time nutrition information about fresh produce, meat, and dairy products. These changes are allowing consumers to assess products in new ways and, in turn, may change consumer preferences.

Conclusions

Feeding everyone with the right foods in optimal quantities are two grand challenges whose solutions will rest on how we handle and harness the unprecedented rate of technological change in the agrifood sector. New management strategies and breeding and processing technologies coordinated across the supply chain and enhanced by digital agriculture will help minimize input use and waste, while maximizing efficiency. Demonstrating product authenticity to consumers, who have access to ever-increasing information about products, remains a challenge and an opportunity to add value. The degree of regulation of new technologies, especially for gene-related technologies, may affect their profitability, however.

Demand-side drivers appear to be the biggest risk in utilization of new technologies. Consumer attitudes can make or break a new technology. Thus, proper consultation and research with consumers is paramount, reinforcing the need for integration across the supply chain.