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THE FUTURE OF FOOD SAFETY



IFSC_1/19/TS3.3

The First FAO/WHO/AU International Food Safety Conference Addis Ababa, 12-13 February 2019

Novel food production

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Introduction: From natural breeding to the Green Revolution, from transgenic crops to recent advances in gene editing and food processing techniques, developments in food and agriculture have proceeded at an increasing speed in recent years. The rapid agricultural advances of the 1950's and 60's (hybrid plants, new synthetic fertilizers, etc.) were followed in the 1990s by a period hallmarked by the use transgenic technology (GM) commercialised primarily in crops such as soybeans, corn and canola. Adoption of new technologies has often been met with consumer scepticism driven by a feeling of uncertainty of the safety of these technologies. Several analyses of the challenges associated with acceptance of new technologies have pointed to the need for greater societal engagement in designing and developing innovation, as well as the need for interactive and trustworthy communication on risks and benefits of new technologies. With the world's increasingly urbanized population growing annually by 80 million, and with growing concern for sustainable use of natural resources, food production systems will need to continue to evolve to meet the needs of all people. New technologies help to meet changing needs. Such technologies include, for example, New Plant Breeding Techniques (NPBT), cultured meat, new processing techniques and personalized nutrition. When shaping and developing innovation, it is important that processes incorporate steps to enable public confidence while at the same time exploiting fully the opportunities made possible through technological and scientific advances.

New Plant Breeding Techniques (NPBT)-(Fourth Agricultural Revolution): NPBT combine more recent advances in genetics and molecular biology than were available 40 years ago. Knowledge about the interaction of various genes in plants has allowed the development of precision gene editing molecular techniques to enable precise changes to turn on or off or alter genetic material at specific locations in a crop's genome. Techniques such as zinc-finger nucleases (ZFNs), transcription activator-like effector nucleases (TALENs), oligonucleotide-directed mutagenesis (ODM) and clustered regulatory interspersed short palindromic repeat associated nucleases (CRISPR) /CRISPR-associated protein 9 (Cas9) (Jinek et al, 2012). With gene editing, changes are made to the existing genome, rather than introducing foreign genetic material. One major technical challenge associated with these technologies is to demonstrate that the traits are maintained under field conditions after they pass proof-of-concept testing in confined environments. Nevertheless, a Canola species has already been described as the first commercially available gene edited crop. It is expected that many other crops are already under development and will follow-suit. Similar to controversies and disagreement over the regulation of GM organisms, there is considerable difference of opinion and debate on how organisms and food derived from NPBT should be regulated. The challenges associated with developing regulations concerning the use of these technologies is complicated by the difficulty of keeping up to date with the rapid pace at which even newer scientific methods are developed. Further regulatory implications at the global level are yet to unfold but disagreements among countries about regulatory models and resulting trade disagreements might be expected to continue to be part of the international landscape unless dialogue at the international level directed towards developing a model of regulatory convergence is enhanced, based on science and risk analysis. It is important that all countries are actively involved in shaping a convergent global regulatory framework. This may require greater attention towards strengthening the capacity of developing countries to master these new technologies and to assess risk and benefit.

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Cultured meat: Advances in cell biology research have been applied to the in vitro culture of animal skeletal muscle cells for food purposes. This technology has the potential to produce high-quality protein that could complement and/or partially substitute for the growing demand for meat proteins. In addition to challenges of consumer acceptance, the use of these so-called lab-grown, cultured meat products as food may require additional evaluation as to how much regulatory oversight to safeguard quality, safety, public and environmental health is necessary. Currently, much debate is on-going about the appropriate name of these products and how they should be regulated. It has been reported that consumers prefer the term "clean meat." Albeit these products are new, a 4% annual growth is expected to result in a market exceeding \$20 million (USD) by 2025, surpassing the anticipated global market share for all other meat substitutes (\$7.5 million) for that same time. However, "newness" should not imply less safe. Consumers perceive risks associated with new food technologies as a primary driver for adoption. Thus, policy-makers need to consider the potential safety and social implications of this rapidly expanding food niche, develop appropriate policies and regulations and engage with consumers to communicate potential risks. The entire synthesis process which brings together cell culture and meat science must undergo a thorough safety audit. A single contamination event or sanitation deficiencies in a large-scale meat synthesis facility could lead to widespread illness. Other regulatory questions demand immediate attention: Which regulatory authorities should be responsible for the safety of cultured meat? Food, Agriculture, Health? Other? The labelling of such food is another regulatory issue? Given that the environmental impact and costs of cultured meat still exceed those for the generation of the same amount of protein from traditional agricultural methods (Alexandrea et al., 2017), is the "clean meat" moniker appropriate? Is this misleading the public? Finally, given the differences in infrastructure and training needed to culture meat proteins compared to producing meat through traditional livestock raising, it is possible that social access to this technology will be limited.

Personalized Nutrition: The advent of next generation sequencing and metagenomic analysis has opened the door to a better understanding of the linkages between nutrition and health. The value of the vast amount of data, on both an individual and a population levels, is currently limited by our ability to analyse and interpret its significance. This field of nutrigenomics, personalized nutrition (and medicine), and microbiome analysis also has the potential to revolutionize nutritional recommendations, but it is still in its infancy. The field is expected to grow at a rapid pace, and despite the limitations, such as the complexity of relationships between individual diet and phenotype, the technology is widely available and heavily marketed to consumers worldwide. Educators and regulators have important roles to play in protecting consumers from hazards that may occur following self-diagnosing and self-treatment of perceived nutritional imbalances employing diagnostic tests that are not fully validated and using unsubstantiated treatment protocols. (Gibney et al. 2016). To protect the public, specific attention should be paid by regulators in ensuring label claims for new products are clear and evidence based.

Novel food Formulations

Dietary patterns and food choices are rapidly changing across the globe. In Low and Middle income Countries, there is a growing trend for pre-prepared foods that are often high in salt, fat and sugars to displace traditional healthier foodstuffs (Stuckler et al., 2012). In addition, the food, beverage and snack food industry are constantly developing new products. With the advent of 3D-printing, it is possible to custom design a variety of shapes of foods wherein, instead of ink, the "printing" is accomplished by extruding food products through its nozzles. Some authors have drawn analogies between 3D food printers and household use of microwave ovens: A new technology in the early 1970's that has today become a common household appliance. The wide-scale household adoption of 3D food printing is tantamount to having large numbers of small-scale food processing or production facilities in private homes. Consideration should be given by policy-makers about expanding food control systems to ensure the safety production and sale of final products produced under these conditions. As new products become more popular, food control systems remain sufficiently resilient and adaptive to assess hazards and develop monitoring and control measures to limit the emergence of new pathogens or the re-emergence of recognized hazards presenting in novel food vehicles or matrices.

Summary

As mentioned above, agriculture and the food we eat is undergoing a radical transformation. To promote trust, consumer acceptance and confidence in the safety of the food supply chain and the environment, regulating authorities should be highly proactive in exploring food trends and communicating information to the public about how any new technologies or their products might be regulated. Input from the public on these issues should be sought, sooner rather than later. In addition, when deciding what information to exclude from public disclosure as confidential business or on other legal grounds, regulating authorities should realise the importance to the public of transparency, access to information, and their right to know what has been done. To address these, and related threats, thorough risk assessments must be completed and appropriate interventions, guidelines and regulations must be developed and enforced to meet the changing face of food production.

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