Technologies shaping the future

To respond to the expected substantial increase in demand for food, agricultural and food industries will need to rely on increased and cost-effective application of existing technologies, as well as on the development of new and innovative ones. Drivers for technology development will include not only demand-led factors, but also socio-political aspects, safety and environmental concerns, and advances in scientific research and development. Technologies will range from those that increase the total quantity of food by diminishing losses and avoiding contamination to those that make food look and taste natural and fresh, reduce components such as fat, sugar and salt, and minimize the use of additives. Enabling technologies such as biotechnology and nanotechnology will play a central role, while information technologies will continue to be essential. Key roles will be also reserved for preservation techniques based upon sterilization and pasteurization, non-thermal technologies, water management techniques including microwave and freeze drying, combined technologies and minimal processing, as well as for technologies based upon the extraction and isolation of specific food components. The implications of these developments for agroindustries will be far reaching. The need to preserve natural resources and optimize the use of inputs will increasingly focus attention on technologies that can assist in preserving the environment and deliver social and economic sustainability. Polices that protect consumers' interests and provide strong support to a country's entrepreneurial base will also be required.

BACKGROUND

We live in a time of great social, economic and technological changes. While close to one billion people suffer from hunger or under-nutrition and another 2 billion are on the borderline of acceptable nutrition, the potential for dramatically improving the economic status of developing countries has never been greater. By the year 2050, the world demand for food will have doubled, driven by the projected increase in the number of low-income consumers who will be lifted out of poverty. Our track record of agricultural output has weaned us away from the Malthusian view of limits to growth, but given the finite nature of our planet, it has also cautioned us on the necessity to pursue technologies and systems that are sustainable.

To face this new world, we have developed an extraordinary set of new technologies that have the potential to produce food where it has never been produced before, in greater quantities than hitherto imagined. Likewise, in several countries the output of meat and fish has increased dramatically, thanks to new management systems. Global phenomena such as global warming must be monitored with extreme precision, as it may be beneficial to some countries while dramatically damaging others. International information exchange has developed to an extent that we can truly say we live in a global village. We are at the apex of a revolution in the global movement of goods and services that would have been impossible to imagine a decade ago.

CHALLENGES

The ability of agricultural and food industries to respond to a substantial increase in demand for food over the coming years will be highly dependent on the increased and cost-effective application of existing technologies as well as exploitation of new and innovative technologies. The increase in demand for food will emanate both from the predicted population growth but perhaps even more importantly from the broad-based economic development in low income countries, the growth of the middle class and the associated dietary changes that will result. Food demand could be as much as twice the current requirement by 2050. The need for technological development and exploitation is further emphasised by the fact that the world's arable land and fresh water are not distributed in the same proportions as the population and, in any case, both land and water will be a constraint on future food production.

DRIVERS FOR TECHNOLOGICAL DEVELOPMENT

The technological development drivers are numerous and varied. They include social, economic, political and environmental aspects. These, as well as the push that will come from advances in scientific research and development, contribute to the development of a broad range of technologies. The nature and intensity of these drivers vary, depending on the country and region. In some countries, the aim to achieve food security is still an important driver.

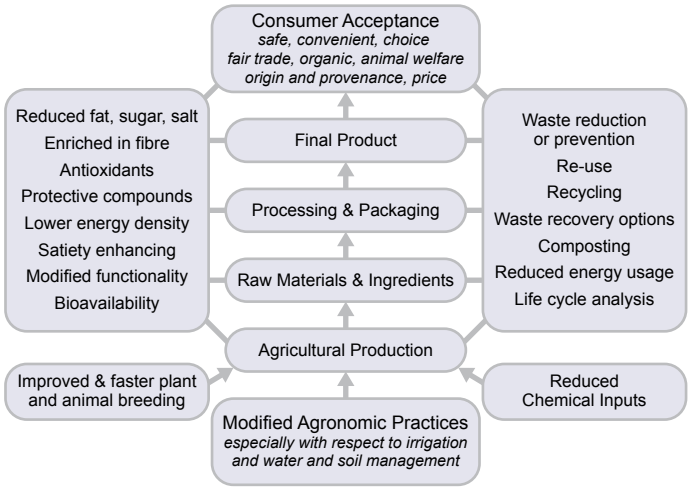
Consumer needs and demands

Consumer attitudes and beliefs are essentially influenced by the degree of availability, accessibility and affordability of foods. These differ considerably between developed economies and low-income countries. The greater availability of affordable convenience and added-value products leads to greater consumer interest in awareness of food safety, quality, nutritional value, health benefits and origin of the products/ ingredients and the technologies involved in their production.

Mouth-feel, texture, and friability are amongst the sensations most evident to consumers. The improvement of these

characteristics requires technologies designed to ensure specific food structures at all stages of production and throughout the life cycle of the end product. Advancements in emulsification and gelation will utilize complex interactions of proteins, lipids, carbohydrates and water to develop flow, viscosity, tensile strength and plasticity to arrive at the most appealing textures.

Future Food Production & Processing Trends



With the increased demand for food and the competing demands for raw materials (e.g. fuel versus food) it is estimated that the cost of agricultural commodities in the next decades will be between 20 and 50 percent above the last 10-year average. This will provide a challenge for economies where food represents a significant share of imports. Countries whose economies allow consumers to think beyond the cost of food often incorporate social, ethical and environmental dimensions into their choices.

Feeding the expanding number of urban populations will increasingly rely on the development of organised processed food industries and related food chains. Their location and extent will depend on cost and availability of raw materials and labour, rate of return on capital investment, transport costs and availability of distribution infrastructure, and costs relating to obtaining regulatory approval for and access to new technologies. Compliance with national and international frameworks will also be important.

Trade Liberalization

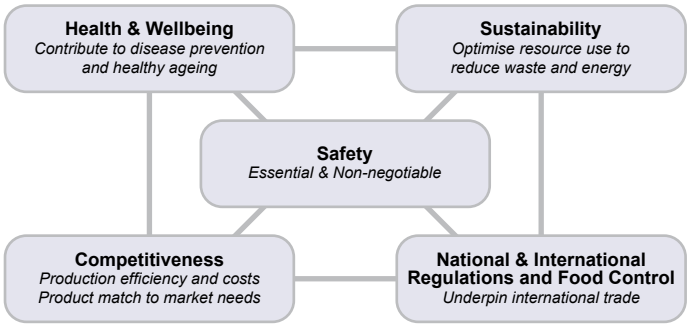
Reduced trading barriers in some countries tend to open the way to much longer distribution chains, requiring products that will maintain safe hygienic quality for longer periods and will meet all sanitary and phytosanitary needs of importing countries. The traditional technologies of heat treatment will be supplemented by cold-processing methods such as ultra high pressure processing and ionizing radiation, both of which are capable of producing products of the highest quality. These technologies will become increasingly important as the recognition of the need to significantly increase our consumption of fruits and vegetables becomes more apparent.

Food Safety

The international movement of goods will require significantly greater attention to food safety. Non-invasive technologies and sensors to monitor the quality of foods on the production line will increasingly replace current time-consuming off-line laboratory techniques. While the SPS and TBT[1] Agreements are predicated upon science-based international standards, individual countries may opt for different levels of protection, depending on their particular requirements. However, because so many goods will be entering the flows of international trade, harmonization of science based safety standards is likely to take place. This will have a profound impact upon food production and processing policies, technologies and practices, as well as on the technical and managerial training required to carry them out.

Future technologies, as with existing ones, have to be designed with food product safety as the essential criterion. This can only be achieved by operating the technology in combination with an effective food safety management system. Such requirements can only be met by ensuring that relevant professionals have been appropriately trained in food safety management as it applies to the technology in question.

Drivers for Technologies shaping the Future



Health Issues

Public policies relating to diet, health and nutrition will also drive the need for technological development. This will require greater understanding of the role that food components play in the perception of taste, flavour and texture and associated enjoyment, in digestive health, general vitality, satiety, weight control and general nutritional status.

An understanding of the bioavailability of functional components such as vitamins, minerals, and antioxidants, as influenced by diet, food structure and processing, is also fundamental. Our concept of nutrition and the impact of technologies may change as we learn more about the fate of food components after ingestion. Nano- and micro-technologies have the potential for protecting and delivering nutrients with greater efficiency.

Environmental Concerns

Regardless of the scale of agriculture employed, the environment will play an increasingly critical role in production. Global warming may result in changes to water availability which will require

[1] Sanitary and Phytosanitary Agreement (SPS); Technical Barriers to Trade Agreement (TBT).

adjustments in agricultural technology as well as broadening of the scale of desalination to include impaired ground waters as well as sea water. This latter technology will require the development of alternative energy sources such as osmotic pressure power generation. The importance of agricultural waste management will favour the development of production systems that are least burdensome on the environment.

The acceptance of the need to preserve natural resources and optimise the use of inputs will increasingly focus attention on sustainability and technologies that can assist in preserving the environment, as well as deliver social and economic sustainability.

Issues of sustainability apply along the whole food supply chain, from agricultural production through ingredients, product and packaging manufacture to storage and distribution via wholesale, retail or food service outlets. More objective data from relevant lifecycle analyses are required to properly evaluate the contribution that different components make to the carbon footprint of food supply chains.

Research, Development and Innovation

The exciting developments in many scientific disciplines, particularly molecular biology, genomics, nutrition and human physiology and psychology, bioinformatics, nanoscience, plant, animal, environmental, material and computer sciences, will continue to provide enabling technologies for the agrifood sector.

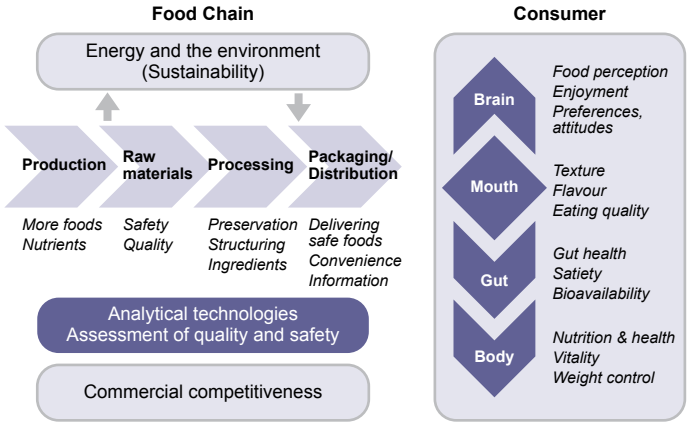
There is little doubt that biotechnology will become a major contributor to future production and processing technologies. The technology will not only be focused upon improving quantitative outputs, but will also be put to work to produce crops with higher levels of beneficial nutrients, such as antioxidants that withstand longer distribution chains and harsh processing conditions.

Current knowledge of human genetics and nutrition continues to make fundamental contributions to improved health and disease prevention. The simultaneous analysis of genetic makeup and nutrient need will result in foods designed to meet a wider range of products focused upon health and well-being. As this happens, additional dimensions to the traditional food chain must be considered. As our knowledge of the complex interactions of digestion develops, we will gain a more comprehensive view of the whole diet. The interactions between various nutrients and the role of various fibers in governing bioavailability and moderating water balance between the digestive and the renal system, among others, will contribute to our future understanding of nutrition. This, in turn, will shape the requirements for technological inputs and innovations along food chains, and particularly in agro-processing activities.

TECHNOLOGIES FOR THE FUTURE

The range of technologies will span from those that increase the total quantity of food by diminishing losses and avoiding contamination to those that make food look and taste natural and fresh, reduce some components such as fat, sugar and salt, and minimize the use of additives. The wealth of existing and developing technologies available, for example, for the separation and transformation of raw materials, and the processing, preservation and packaging of finished products, must be used in order to deliver ingredients and final products to customers and consumers that are safe and contribute to health, well-being and sustainability, while enabling companies and entrepreneurs to operate competitively within agreed national and international regulatory frameworks. The opportunities available will be enhanced by enabling technologies, such as biotechnology and nanotechnology, while information technologies will continue to be pivotal for business and the public sector in an increasingly interdependent and interconnected world.

The two axes shaping the targets of food technologies for the next decades



Among the food technologies that are expected to play a major role in the future of food processing will be: preservation techniques based upon sterilization and pasteurization; non-thermal technologies, such as irradiation and ultra-high-pressure processing; water management techniques including microwave and freeze drying, combined technologies and minimal processing, as well as those based upon the extraction and isolation of specific food components, such as anti-oxidants, flavours, specialized lipids and other functional ingredients. Agricultural products may be bio-engineered to produce large outputs of these specific materials, and modern extractive technologies, such as supercritical extraction, will be employed to yield healthier, higher quality products with a reduced negative impact on the environment.

ENABLING FACTORS

Technologies are not applied in isolation. They are implemented by private entrepreneurs and companies that perceive a stable and propitious environment for their long-term investments. In general, it is required that food policies applied to technology provide an enabling environment for entrepreneurs, create fiscal incentives for innovation, supply the necessary infrastructure for entrepreneurship (including the availability of appropriate training and development) and promote the adequate backward (e.g. financial support to small and medium enterprises, risk capital, and information about future markets) and forward linkages (e.g. international promotion, national brands).

Developing countries interested in establishing or strengthening a food export business will have to face institutional changes to oversee all activities in the food production chain and not just in agricultural production. Public policies also need to ensure a basic science and technology system that provides support to the local agro-industry and promotes the entrance of new small and medium entrepreneurs into the business. The formation of interconnected technology clusters where suppliers, food processors, government agencies, research providers and trade associations come together to facilitate the innovation process must be encouraged.

All of the above have to be supported by regulatory frameworks and enforcement strategies that protect consumers' interests locally and abroad and assure the highest standards of food safety and hygiene.

With regard to the movement of food, technologies and systems with the ability to support extended distribution chains will become increasingly important. Ready access to foods from around the world will have consequences on the dietary patterns of all individuals. Together with the movement of goods and people, there is a distinct possibility of creating pandemics through the parallel movement of infectious diseases. This makes the promulgation and implementation of internationally harmonized high-quality standards imperative.

We have seen the great cache of physical, chemical and biological technologies available to entrepreneurs for the production and processing of foods. Perhaps the greatest tool available to them is the rapid advancement of information and communication technologies (ICT). While food processing technology has empowered entrepreneurs to produce products of higher quality, convenience and market potential, ICT has provided the direct access and connections to promote and sell them.

For the first time, entrepreneurs in developing countries have a very strong potential to access international markets with an unprecedented degree of independence. However, the potential to capitalize on this will be largely contingent upon the economic policies in place. Such policies must provide strong support to the country's entrepreneurial base. When properly implemented, these policies will have the consequent benefit of generating employment and general economic development, from which all will benefit.

Agro- industrial development policy should not add to the risk of entrepreneurs, but encourage the application of sound, proven methods for the manufacturing of final products. It is important to consider sustainability in context and carefully adjust its significance within the hierarchy of imperatives weighted to achieve rational and successful industrial development. The globalization of the economy has provided entrepreneurs with vastly greater markets. In light of these new developments, policies must support entrepreneurial competitiveness in rapidly changing markets.

It is critical that governments send their most qualified people as negotiators to international fora, such as the Codex Alimentarius Commission. Although these meetings generally revolve around technical matters, such as standards and analysis, consideration must be given to representation by highly trained negotiators and well-briefed legal officials who understand the long-term significance of standards in trade. The subject of these meetings may be technical, but the consequences are definitely economic.

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Useful Web sites

The Rural Infrastructure and Agro-Industries Division of FAO: www.fao.org/ag/ags/subjects/en/industFoodAg/index.html

The Agro-industry service module of UNIDO: www.unido.org/doc/18256

Credits

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