



IUFOST Scientific Information Bulletin (SIB)  
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## **The role of food science and technology in combating food insecurity**

### **Background**

The World Food Summit of 1996 defined **food security** as existing “*when all people at all times have access to sufficient, safe, nutritious food to maintain a healthy and active life*”. Commonly, the concept of food security is defined as including both physical and economic access to food that meets people's dietary needs as well as their food preferences. Food security is built on three pillars:

- Food availability: sufficient quantities of food available on a consistent basis.
- Food access: having sufficient resources to obtain appropriate foods for a nutritious diet.
- Food use: appropriate use based on knowledge of basic nutrition and care, as well as adequate water and sanitation.

(WHO, <http://www.who.int/trade/glossary/story028/en/> )

**Food insecurity** exists when people do not have adequate physical, social or economic access to food as defined above. It is a complex not only of inadequate quantity where it is needed but of inadequate quality, i.e. for vast numbers of people the lack of foods with the necessary micronutrients and of clean water, for reasonable nutrition and health. In 2009, for the first time since 1970, more than one billion people – about 100 million more than in 2008 and around one sixth of all of humanity – are hungry and undernourished worldwide. The FAO Report “The State of Food Insecurity in the World 2009” (FAO, 2010) sets out the full picture, with extensive data on prevalence of undernourishment and progress towards the World Food Summit (WFS) and the Millennium Development Goal (MDG) targets in developing countries, selected food and financial indicators in developing countries, classified by region, and case studies of some countries affected by the economic crisis.

There are many factors currently contributing to or aggravating food insecurity; poverty, poor health, natural disasters, poor soil, water shortages, use of food crops for biofuel, political and economic factors, wars, corrupt governments, and the global economic crisis.

Moreover, in decades to come, with the expected substantial increase in the world population (9.1 billion by 2050), mostly in the poorest, least developed countries, coupled with the possible effects of climate change, the demand for food and for water will greatly increase. Thus, combating food insecurity must address both the present problem and the growing future one.

There are many factors beyond the ability of food science and technology to control, or its expertise to ameliorate. Of course the problem that has huge political and economic dimensions will not be solved by food science and technology alone. or even by science alone -- but will certainly not be solved without the contribution of food science and technology.

This was recognised at the 9<sup>th</sup> World Congress of Food Science & Technology, when IUFoST committed itself to the Budapest Declaration (IUFoST, 1995) from which the following quotations are relevant.

*We are especially concerned by the high prevalence and increasing numbers of malnourished children under five years of age in parts of Africa, Asia and Latin America and the Caribbean as well as other parts of the world. Moreover, 2000 million people, mostly women and children, are deficient in one or more micronutrients; babies continue to be born mentally retarded as a result of iodine deficiency; children go blind and die of vitamin A deficiency; and enormous numbers of women and children are adversely affected by iron deficiency. Hundreds of millions of people, particularly young children, pregnant women, the immunocompromised and the elderly, also suffer from communicable and non-communicable diseases caused by contaminated food and drinking water. At the same time, chronic non-communicable diseases related to unbalanced dietary intakes often lead to premature deaths. Taken together, these diseases result in enormous health care costs as well as important losses due to reduced economic productivity. We recognise that the contributions of food science and technology are essential in solving many of these problems, especially those related to inappropriate dietary intakes, food hazards and micronutrient deficiencies.*

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*We recognise that poverty and limited access to education, which are commonly the effects of underdevelopment, are often major causes of hunger and undernutrition. There are poor people in most societies who do not have adequate access to food, safe water and sanitation, health services and education, which are the basic requirements for nutritional well-being. To overcome these problems, there is an urgent need to strengthen the food science and technology base to support food and agriculture sectors, especially in low-income, food-deficit countries, in order to expand and diversify food supplies, create income-earning opportunities and generate local resources for development.*

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*We recognise that food science and technology inputs together with modern biotechnology are essential in many basic and applied scientific research programmes. We further recognise our responsibility to promote public understanding of issues involving food science and technology, so that public support and acceptance allow the timely introduction of beneficial applications of present and emerging new technologies.*

The topic of water for food and farming, and the need for a fresh perspective on water and food management in light of the concerns of rising incomes and changing diets, urbanisation, and population growth in developing countries, have been separately addressed in an IUFoST Scientific Information Bulletin (IUFoST, 2010b) and by the UK Royal Academy of Engineering (RAE, 2010).

This Scientific Information Bulletin specifically considers the role of food science and technology in the application of existing scientific/technological knowledge and research into improved knowledge in

- food safety;
- increasing agricultural productivity;
- improving the quantity, safety and nutritional quality of crops and animals by all available "tools", including biotechnology;
- minimising post-harvest losses;
- education of "grassroots" people in understanding and utilising these applications.

### **Food safety**

The food security definition requires that all should have access to “sufficient, safe, nutritious food” so food safety is a vital component of food security.

“Safety” literally means complete absence of risk. Nothing in life is entirely risk-free, and indeed science cannot demonstrate freedom from risk, particularly from as yet unknown risks, because “absence of evidence” is not “evidence of absence”. Science cannot know, and can never know, all there is to know about any topic. In practice, therefore, a realistic definition of safety is the absence of foreseeable *unacceptable* risk or, to use a term borrowed from the World Trade Organisation “an appropriate level of protection” (ALOP). What constitutes ALOP is the responsibility of legislators, after risk analysis carried out by relevant experts and consultations with relevant stakeholders; and is expressed in the form of laws, regulations, codes of practice and guidelines in each country and is subject to subsequent case law based on Court decisions; although a food producer may choose to operate stricter standards than the law requires. Moreover, regulatory requirements, apart from country-to-country variation, are not immutable and may themselves be changed. There is, of course, nothing to prevent a food producer seeking to achieve a higher level of protection than the ALOP of the country for which the food is intended. For practical purposes, references to "safety" and “safe” in this Bulletin should be interpreted as meaning achieving ALOP.

It follows that the food producer needs to make use of up-to-date food science and technology knowledge to ensure that the manufacturing or preparation process delivers a product that achieves ALOP while providing as effective freedom from post-process chemical or microbiological contamination as it is realistically possible to achieve, and while complying with relevant regulatory requirements and also uniformly fulfilling the quality parameters (e.g. colour, flavour, texture, mouthfeel, freedom from defects and from foreign matter) built-in to the product specification.

### **Increasing agricultural productivity**

Increased agricultural productivity means an improved ratio of desired outputs (crops or animals usable for food) to inputs (of labour, of cost, of fuel, of transport).

The part that biotechnology is playing, and can increasingly play in relation to all aspects of the food supply has been addressed in the IUFoST Scientific Bulletin on “Biotechnology and Food” (IUFoST, 2010a). In respect of increasing agricultural productivity, biotechnology can:

- reduce tillage with consequent soil benefit, and reduce hand-weeding;
- reduce pesticide and herbicide usages, with less concomitant fuel usage. less carbon emissions and with environmental and cost reduction benefits;

- improve yields through reduction of pre-harvest losses;
- improve yields by development of disease-resistant crop varieties;
- enable optimum feed composition and quality for optimal conversion by animals selected for such feeds, with concomitant benefits for the environment (e.g. development of low-phytate seeds that reduce phosphorus and nitrogen levels in wastes).

Increased agricultural productivity faces wider challenges in developing countries especially in sub-Saharan Africa and South Asia. The on-line report "Emerging Technologies to Benefit Farmers in Sub-Saharan Africa and South Asia" (also published as a book) (US NRC 2008a) states:

*"Increased agricultural productivity is a major stepping stone on the path out of poverty in sub-Saharan Africa and South Asia, but farmers there face tremendous challenges improving production. Poor soil, inefficient water use, and a lack of access to plant breeding resources, nutritious animal feed, high quality seed, and fuel and electricity combined with some of the most extreme environmental conditions on Earth have made yields in crop and animal production far lower in these regions than world averages."*

The report identifies sixty emerging technologies with the potential to significantly improve agricultural productivity in sub-Saharan Africa and South Asia. Eighteen technologies are recommended for immediate development or further exploration (US NRC 2008b). Scientists from all backgrounds have an opportunity to become involved in bringing these and other technologies to fruition. The opportunities suggested in this book offer new approaches that can synergize with each other and with many other activities to transform agriculture in sub-Saharan Africa and South Asia (*idem*). The following Table, reproduced from the Report, names the eighteen priority technologies and the Chapters in which each is discussed.

**TABLE 8-1** Priority Tools and Technologies to Improve Agriculture in Sub-Saharan Africa and South Asia

Tier I High Priority for Application Development	Tier II High Priority for Additional Exploration
Soil management techniques— <a href="#">Chapter 5</a>	Soil-related nanomaterials— <a href="#">Chapter 5</a>
Integrated water management— <a href="#">Chapter 4</a>	Manipulation of the rhizosphere— <a href="#">Chapter 5</a>
Climate and weather prediction— <a href="#">Chapter 4</a>	Site-specific gene integration— <a href="#">Chapter 3</a>
Annotated crop genomes— <a href="#">Chapter 3</a>	Remote sensing of plant physiology— <a href="#">Chapter 3</a>
Genome-based animal breeding— <a href="#">Chapter 6</a>	Microbial genomics of the rumen— <a href="#">Chapter 6</a>
Plant-mediated gene silencing— <a href="#">Chapter 3</a>	Sperm stem cell transplantation— <a href="#">Chapter 6</a>
Biocontrol and biopesticides— <a href="#">Chapter 3</a>	Solar energy— <a href="#">Chapter 7</a>
Disease-suppressive soils— <a href="#">Chapter 5</a>	Photosynthetic microbe-based biofuels— <a href="#">Chapter 7</a>
Animal vaccines— <a href="#">Chapter 5</a>	Energy storage— <a href="#">Chapter 7</a>

## **Improving the quantity and nutritional quality of crops and animals by all available "tools"**

While conventional means of plant and animal breeding continue to have an important part to play, much greater benefits could be achieved more quickly by current and future development in the use of biotechnology, not only in modifying plants and animals but by making available for cultivation land that has been virtually unusable for agriculture. Thus, it could:

- reduce the number of food-deficient regions of the world through the development of stress-resistant crop varieties more amenable to growing on poor soils (such as saline soils and aluminium-rich soils) and crop varieties better able to grow under drought conditions (especially maize) or flood conditions (especially rice);
- improve the shelf life of fresh fruits and vegetables;
- more easily reduce the levels of allergens, naturally-occurring toxicants and other undesirable constituents in food crops;
- increase the levels of desirable disease-resisting and health-promoting food constituents (i.e. functional foods and nutraceuticals),
- improve the sensory and nutritional qualities of foods (e.g. levels of vitamins A, E, desirable fatty acids, iron, fibre);
- produce a variety of ingredients and processing aids (e.g. enzymes, microorganisms),
- be used to improve desired features of farmed animals, including fish, such as disease resistance and food production with improved qualities (e.g. lower in fat or fat modified, higher yields of prime cuts, better feed conversion, reduced methane production).

## **Minimising post-harvest losses**

Post-harvest losses occur due to inadequate protection from physical, chemical and microbiological deterioration, or due to attack by insects and pests during transport and storage. Protection can be provided by

- established food preservation processes (such as dehydration and drying, freezing, thermal processes, fermentation);
- emerging and new technologies (such as those described in the IUFOST Scientific Information Bulletin "Emerging and New Technologies in Food Science and Technology" (IUFOST, 2010c);
- effective packaging and transport conditions;
- measures to deter insect and pest attack.

Protection methods are needed that are applicable for village use, including for traditional foods, but methods are also needed for larger-scale production for urban populations.

The FAO INPhO Portal "Information Network on Post-harvest Operations"

<http://www.fao.org/inpho/isma?i=INPhO&p=index.jsp&lang=en>

provides a vast on-line accessible treasure house (including searchable databases), of protection methods assembled over the years. The Post-harvest-compendium targets crops producers. It is designed to be used through the Internet to provide technical and updated information about how, when and what is done after production of the crops in different communities around the world. It also provides information on other aspects associated with post-harvest activities, including teaching and learning materials on education for rural people.

IUFOST has an on-line book, to which new chapters are being added, "Using Food Science and Technology to Improve Nutrition and Promote National Development: Selected Case Studies" (IUFOST 2008 and updating). The current contents are as follows:

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“Millions Fed” is a project led by the International Food Policy Research Institute (IFPRI) , with support from the Bill and Melinda Gates Foundation, to identify policies, programs, and investments that have actually reduced hunger and poverty in the developing world. The goal was to collect evidence about where, when, and why these interventions succeeded, learn about the key drivers and factors underlying success, and share lessons to help inform better policy and investment decisions in the future. More than 250 candidate case studies were submitted and evaluated using a comprehensive set of criteria that took into account such issues as scale, impact, and sustainability. Ultimately, the project identified 20 case studies, which are featured in the downloadable book “Millions Fed: Proven Successes in Agricultural Development” (Spielman and Pandya-Lorch 2009).

### **Education of "grassroots" people in understanding and utilising these applications**

“Grassroots” implies people at the practical forefront of preparing food, both in urban facilities and at the village level.

IUFoST provides education and training for food scientists and technologists around the world by providing experts for short courses, organizing conferences and symposia alongside IUFoST Adhering Bodies and by providing resources where there is need.

IUFoST has identified the development of a distance education training program for food industry workers in Sub-Saharan Africa (SSA) as a major initiative. This was begun through the need expressed by SSA food industry for enhanced training of mid-level employees already in the food sector who do not have the necessary formal education in the field or access to it. Training of these individuals is viewed as one way of addressing problems associated with establishing a reliable and sustainable supply of safe and nutritious food for the people of this region. IUFoST’s Distance Education Task Force chaired by Dr. Daryl Lund has recruited a group of well-known scientists to prepare a set of training modules to meet its training objectives. There will ultimately be nine subject-matter modules in the Sub-Saharan Distance Education Initiative. Each module will have one to three levels (introductory, intermediate and advanced) depending on the subject matter. The modules are:

- Food Safety
- Quality Assurance (including HACCP)
- Food Laws and Regulations
- Shelf-Life of Foods (including food losses)
- Thermal Processing
- Dehydration and Drying
- Food Freezing
- Food Packaging
- Practical Human Nutrition

FAO has a site “Education for Rural People” (ERP) -- “a Compendium of FAO experience in basic education: all for education and food for all”

[http://www.fao.org/sd/erp/toolkit/ERPtkviewdata\\_en.asp?CodeSubSubject=1&NameCategory=Trees%20and%20Forests](http://www.fao.org/sd/erp/toolkit/ERPtkviewdata_en.asp?CodeSubSubject=1&NameCategory=Trees%20and%20Forests)

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*Prepared by Ralph Blanchfield on behalf of, and approved by, the IUFoST Scientific Council.  
Professor Ralph Blanchfield, MBE, is a member of the IUFoST Scientific Council and the  
Immediate Past President of the International Academy of Food Science and Technology  
(IAFoST).*

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The International Union of Food Science and Technology (IUFoST) is the global scientific organisation representing over 200,000 food scientists and technologists from more than 65 countries. It is a voluntary, nonprofit association of national food science organisations linking the world's food scientists and technologists. IUFoST has four regional groupings, ALACCTA representing Central and South America, EFFoST representing Europe, FIFSTA representing the ASEAN countries and WAAFoST representing West Africa.

IUFoST Contact: J. Meech, Secretary-General, IUFoST, P O Box 61021, No. 19, 511 Maple Grove Drive, Oakville, Ontario, Canada, L6J 6X0, Telephone: + 1 905 815 1926, Fax: + 1 905 815 1574, e-mail: [jmeech@iufost.org](mailto:jmeech@iufost.org) [www.iufost.org](http://www.iufost.org)

