GLOBAL GOVERNANCE AND THE ROLE OF FOOD SCIENCE AND TECHNOLOGY FOR SUSTAINABLE FOOD SYSTEMS

Including Briefs on Traditional Food and Processes and Food Science and Technology Education and Training for Capacity Building

Report prepared by the International Union of Food Science and Technology (IUFoST)

IUFoST response to the opportunity offered by His Excellency Antonio Guterres, United Nations Secretary-General, to provide scientific input for the Food Systems Summit 2021. Findings and Recommendations for Actions are included arising from consultations with national scientific organizations adhering to IUFoST and with interdisciplinary partners within the International Science Council, with other international organization representatives in WHO, FAO, UNIDO, UNEP, global NGOs, women's cooperatives and individuals across the food supply chain from farm to table.

SDG "Sustainable Development Goal" References Applicable to Food Science and Technology

Thirteen of the seventeen United Nations Sustainable Development Goals (SDGs) directly reference food. The application of Food Science and Technology skills are needed to help achieve these specific SDGs:

No poverty (Goal 1)
Zero hunger (Goal 2)
Good health and wellbeing (Goal 3)
Quality education (Goal 4)
Clean water and sanitation (Goal 6)
Affordable and clean energy (Goal 7)
Decent work and economic growth (Goal 8)
Industry, innovation and infrastructure (Goal 9)
Responsible consumption and production (Goal 12)
Climate action (Goal 13)
Life below water (Goal 14)
Life on land (Goal 15)
Partnerships for the goals (Goal 17)

UN Summit Identified Action Tracks Applicable to Food Science and Technology

Action Track 1: Ensure access to safe and nutritious food for all
Action Track 2: Shift to sustainable consumption patterns
Action Track 3: Boost nature-positive production
Action Track 4: Advance equitable livelihoods
Action Track 5: Building resilience to vulnerabilities, shocks and stress

Section 1:
INTRODUCTION:

Nations around the world are facing serious challenges related to food, water and energy security, health and environmental change, and ever-increasing demands for science advice. The global pandemic has accelerated the need for a comprehensive and collective global response to the needs of future food systems. Food systems involve all processes related to food - from the production, processing, and distribution of food, to its preparation and consumption.

Representing the international discipline of Food Science and Technology, IUFoST members, affiliates and interdisciplinary partners and fellows of the Academy are enabled by our ongoing commitment to the UN Sustainable Development Goals; by commitment through the IUFoST Budapest and Cape Town Declarations to the objectives of the International Conference on Nutrition (ICN) and World Declaration on Nutrition. Food scientists, technologists and engineers have re-committed themselves to being active participants and agents for positive change towards a strong and resilient food system through contributions to the UN Food Systems Summit and the work arising.

Historical Context

The ICN that led to the IUFoST Budapest and Cape Town Declarations of food scientists, technologists and engineers brought about a number of programs and policies that were instrumental in creating an appropriate environment for revitalizing the agriculture sector. The national plan of action was then finalized based on the country papers that were prepared at that time. Among the achievements, the Ministry of Agriculture was re-named in some countries as Ministry of Food and Agriculture.

This was a significant achievement in the recognition of the interdependence of agricultural raw materials to food production and sustainable food consumption. Food Science and Technology is identified as being involved in all post-harvest activities from farm to consumer and should also have a voice in agriculture from the perspective of efficient and affordable food chain, including transportation, mitigation of post-harvest losses, safe handling, retention of nutrients and environmentally friendly choices for manufacturing, including marine and aquaculture challenges (reference Blue Revolution).

That landmark meeting serves as a reference point for possible change through government action, industrial action, educational improvements at local, national, regional, and international levels. The acknowledgment that Food Science and Technology must be part of policy decisions at all levels provides the basis on which future resilient and sustainable food systems will develop globally.

Food science and technology focus

Food Science and Technology through IUFoST has structured itself on a framework to meet the future food security challenges – through filling the void in the supply side gaps and influencing demand changes and including Nutrition into food security, reduction of the production gaps, increasing the efficiency of post-farm operations and influencing demand. This approach was refined into a food science and technology food system approach on which the IUFoST Expert Food Security panel presented highlights and potential future actions. A report on these IUFoST proceedings is found in The Science of Food 2018 by Martin Cole et al *on The science of food security* (publication details in Appendix 3). Food Systems must reflect food security, food safety and nutrition to produce healthy diets. Most of the approaches are taken in the global context and therefore lose the importance of the local contexts. The COVID 19 pandemic is teaching us the limitation of mobilizing commodities globally. It is the availability of local resources that is the key for resiliency.

Government recognition of IUFoST

The first IUFoST Food Systems Summit in 2016 was convened and hosted by the Irish Government to coincide with the World Congress of Food Science and Technology. The food security sessions that followed included more analysis and specific examples of actions by different actors in the food systems, and clearly demonstrated the need to consider and integrate drivers relevant to each step of the current and emerging food chains.

The Summit had representatives from governments, their agencies, and their departments as well as representatives from high-level NGOs and global institutes. It was not just a forum for more scientific exchange, but for high-level dialogue among decision-makers. The then European Commissioner of Agriculture, opened the Summit with the "big challenges" facing Europe and the world in the areas of *nutrition and health, climate and sustainability, resource efficiency, innovation, and addressing the needs of the rural communities*. These are all important areas to which IUFoST has been challenged to respond and to make a meaningful contribution. The role of food science and technology in meeting societal and technological change is referenced in the report of IAFoST Fellows A-H Hermansson/P. Lillford, authors of *Global missions and the critical needs of food science and technology*, Trends in Food Science 2020 – Appendix 3.)

Toward Mobilization

This first IUFoST-led Summit recognized the importance of international food science and technology contributing to governmental policy, with IUFoST as the representative international organization that can lead in the identification of needs, development of research prioritization and the underpinning of the formation of advice and implementation of policy for a more secure and resilient global food system.

As examples, the ongoing work areas of food science and technology have included actions to reduce food losses and waste; mitigating environmental effects through development of new technologies; expanding knowledge of traditional foods and processes and their immune functions; educating the consumer on food choices and introducing new alternatives, expanding knowledge of how food reacts with the body to reduce over and undernutrition, improve capacity building and education and training at all levels. Empowering the existing IUFoST organization through its national scientific bodies globally and Fellows of the International Academy of Food Science and Technology (IAFoST) and its partners can contribute to address food system issues at the global level that meet the local needs as well and therefore the food system will be more sustainable.

The next gathering of international food science and technology and across disciplines was held in September 2020 and as reported in these pages re-affirmed the action areas that need food science and technology and policy involvement to ensure resilient and sustainable future food systems. Governmental policy around funding, research and development, education and resources, mobilization of the workforce with equitable distribution of opportunity, and access to safe, sufficient and nutritious food is fundamental and Food Science and Technological expertise must be employed to ensure the security, sufficiency and safety of future food systems.

Section 2:
INTERDISCIPLINARY MOBILIZATION OF FOOD SCIENCE AND TECHNOLOGY FROM LOCAL NEEDS TO GLOBAL GOALS FOR SUSTAINABLE AND RESILIENT FOOD SYSTEMS

Food Science and Technology has developed dramatically in recent years due to the collaboration of governments and multinational players in the food chain. This has caused the commoditisation of high

yielding crops; global trading of raw materials: standardisation of large-scale processing plants: and the establishment of international branded products. This is economically efficient, but sustainable ONLY if energy prices are low and international movement of materials is possible. Such a system, while economically sound, can denude local food chains and is therefore fragile to global emergencies. This has been exposed dramatically during the pandemic. Food supply however, is vital, so the strength of local efficient supply chains is the basis of sustainability. Food also comes in so many forms and with such varied technological bases for its safe production that local competence in FS&T is vital. (Examples are given in the supporting documents). Expertise in FS&T should therefore be considered strategic to every nation state.

Food scientists, technologists and engineers, through IUFoST, have continued to work in interdisciplinary collaboration in many areas around improving the sustainability of food systems and food safety, sufficient and nutritious food for a healthy diet surrounded by the current global health crisis since its onset in late 2019. The COVID-19 pandemic has exponentially heightened the need for collaborative and immediate actions to alleviate suffering. Scientific dissemination of appropriate information and technologies to meet immediate local and global needs has been a focus area for IUFoST. To date, seven Scientific Roundtable meetings have been held with an 8th around Traditional Foods in place for April 2021. Their purpose has been to include and inform global scientists in an interdisciplinary approach to help solve specific issues and to disseminate information globally that is science-based and can provide benchmarking, action plans and concerted global action.

<u>IUFoST Scientific Roundtables and Second Summit</u>

· The first, on the subject of Food Losses and Food Waste brought together different disciplines and experts from FAO, IUNS, IFPRI, USDA, CSIRO, CSIR and Experts on Food Safety and Emerging Technologies from Laboratories in Greece and Switzerland.

· The second, on the subject of Climate Change and Food included a Nobel Laureate, as panel member on Climate Change and experts from Montpellier SupAgro, CGIAR Foresight, Engineering Geology, African Food and Agriculture Skills Development Centre; together with the former scientific advisor to two US Secretaries of State and Fellow of the National Academy of Science, USA.

· The next, organized just as the pandemic was becoming globally recognized, was held by IUFoST in March 2020, co-organised with our national scientific body in China, Chinese Institute of Food Science and Technology, to look at Food Safety in the midst of COVID-19. (Reference *IUFoST/CIFST Hold an Extraordinary Scientific Roundtable on COVID-19 and Foo*d *Safety*, Science of Food 2020, author Gerald Moy, and *Does COVID-19 Affect Food Safety and Security?* Journal of Food Bioactives 2020, Fereidoon Shahidi author, see Appendix 3.

· This ground-breaking Scientific Roundtable was followed with a scientific Roundtable that focussed on Africa and the Near East and how COVID-19 was manifesting itself in the food systems and the potential devastation that it can bring about. The fundamental fracturing of weak food systems in many countries, and also including developed economies was a focus.

· In this series around COVID-19, the next scientific roundtable gathered food regulators and representatives of the food production sector from Asia, Europe, South America and the Middle East. It was co-hosted by IUFoST with the Sustainable Food Systems Division of the United Nations Industrial Development Organization (UNIDO) and the Food Risk Analysis and Regulatory Excellence Platform (PARERA) of Université Laval, Québec, Canada.

In September 2020, a second Summit to look at Food Systems was convened by IUFoST to assess and recalibrate work in light of recent pressures on the Food Systems as identified in its series of cross-disciplinary and scientific meetings and in preparation for the UN Food Systems Summit in 2021. The purpose was to look for new strategies - followed by concrete actions.

Prior to this Summit and subsequent to it on an ongoing basis, IUFoST has investigated specific issues around future food systems that require the expertise of the discipline of Food Science and Technology to provide a sustainable, resilient food system going forward. One such example is the coordination with the Chinese Institute of Food Science and Technology, IUFoST Adhering Body in China, of the high-level International Forum held most recently in December 2020 on the subject of Food Safety and Health. Many levels of government were involved and the international science presented centered around food systems issues including 'cold chain', plant-based diets, over and undernutrition, entrepreneurship. This Forum, which was arranged at the request of the Chinese Government, has been acknowledged by a former Under Secretary of Agriculture, USA as the most important and influential on Food Safety and Health discussions in China.

The second IUFoST Summit in September 2020 *included Gordon McBean, Past President of International Council for Science (now ISC), Co-founder of Future Earth and Nobel Laurea*te who spoke on the *Challenge of feeding the pandemic world today and tomorrow.* To respond to these challenges, he suggested that a multi-disciplinary approach with a climate change perspective was needed but would require good governance to implement (reference Gordon McBean *Integrating Science to Address Food and Health Within the Global Agenda 2030*, Nature of Food 2021– Appendix 3).

*Catherine Bertini, former Executive Director, World Food Programme, recipient of the World Food Pri*ze *and Fellow of the International Academy of Food Science and Technology* (IAFoST) noted key areas to successfully transform food systems including improved research and development with emphasis on post-harvest, reduction of obesity, a risk factor of serious COVID-19 infection, greater involvement of women and girls, greater investment in agriculture and the importance of good governance at national and regional levels.

Charles Godfray, Director of the Oxford Martin School, University of Oxford, England speaking from the perspective of a population biologist, stressed that pre-existing health issues had become critical during the COVID-19 pandemic, highlighting experiences from the United Kingdom, and noted that food production must be sustainable and intensified, diets need to be healthier and contain more sustainable foods and food wastage, which is estimated to amount to a third of all food produced, must be reduced.

Joachim von Braun, Chair of the Scientific Group, UN Food Systems Summit 2021 was sure that IUFoST would be an important partner in the effort to achieve a safe, secure and sustainable food supply and achieve UN summit goals.

Junshi Chen, Member, Chinese Academy of Engineering; Chief Advisor of China National Centre for Food Safety Risk Assessment in his submission stressed that the psychological effects of COVID 19 can be greater than the COVID-19 food safety risks, so good communication is also needed.

Johanna Lindahl, Scientist, International Livestock Research Institute, Vietnam who discussed food safety in the informal sector warned against the dangers of pushing towards more formal value chains in LMIC without recognizing the economic importance of the informal food sector.

Alexandre Novachi, Technical Director, ABIA (*Associacao Brasileira da Industria de Alimentacao*) in reviewing the impact of the COVID-19 pandemic on the food industry, emphasized the importance of information from trusted scientific sources for consumers.

Samuel Godefroy, former Director General of Health Canada's Food Directorate, former Vice Chair of the FAO/WHO Codex Alimentarius Commission, Full Professor University of Laval Canada stressed the critical

importance of international collaboration and regional and global networks on food regulatory systems in mitigating disruptions cause by the COVID-19 pandemic.

Ruth Oniang'o Chair Sasakawa Africa Association; Founder, Rural Outreach Africa; Africa Food Prize Laureate, Board Director, CABI emphasized the urgent need to mobilise young people and improve and expand skills development training and re-training for food security and stability.

V. Prakash, former Distinguished Scientist, CSIR India and IUFoST President stressed the role that safe and nutritious foods can play in promoting immune functions and the need for innovative approaches by the food industry in ensuring sustainability and building resilience.

The presentations by *Alejandra Medrano, Laboratorio de Bioactividad y Nanotecnologia de Alimentos and ALACCTA (regional grouping of IUFoST for Central and South America)*, *Dr. Lara Hanna-Wakim, Vice Director, Higher Center for Research, Full Professor at the Holy Spirit University of Kaslik (USEK), Lebanon* and *Ali Badarneh, Chief of the Sustainable Food Systems Division, Agri-Business Development Department, at the United Nations Industrial Development Organization (UNIDO)* dwelt on the scientific data they had accumulated on impacts of the COVID-19 pandemic on food consumption, especially foods that improve immunity, the serious challenges relating to food, water and energy security, the decline in industrial production globally, and the need to make food systems more sustainable and build resilience going forward.

John McDermott, Director, CGIAR Research Program on Agriculture for Nutrition and Health, International Food Policy Research Institute (IFPRI) and Chair of IUFoST Food Security Committee focused on the mobilization of resources- people, institutional partners and money - by IUFoST for the major purposes of research, training and education.

SUMMIT RECOMMENDATIONS FOR ACTION FOR GOOD GOVERNANCE TO SUPPORT RESILIENT AND SUSTAINABLE FUTURE FOOD SYSTEMS

1. Reinforce that Food Science and Technology expertise is critical to governmental policy at local, regional and international levels as it has an impact on all post-harvest activity from farm and table. The discipline of Food Science and technology works in multi-disciplinary capacities with many partners on an ongoing basis and it is a necessary partner in achieving safe, sufficient and sustainable food for a healthy diet. Scientific evidence, facts and definitions are needed about healthy diets. More research is needed on total diet studies, including socio, cultural and economic studies. The effects of food processing and preservation must be included in any healthy diet study.

2. Include food scientists, technologists and engineers in agricultural and urban policy, environmental discussions as they have key roles to play in improving the industrial sector and food chain to improve sustainability and resiliency.

3. Promote the importance of food processing to provide sufficient food that is safe, has a longer shelf life and provides enhanced nutrition. Improve opportunities to Food Science and Technology through increased R&D, education and enhancement of pilot plant facilities to develop new technologies to further improve food for a healthy diet, to look at improved immune functions of raw materials and how to process them in an environmentally sustainable manner. Improvement of food safety and prevention of food-borne diseases through processing and preservation need to be recognized.

4. Involve food scientists, technologists, and engineers in capacity building, education and training with particular reference to mobilizing young people to train in food related careers and to improve food safety and security from the community setting through to urban centers.

5. Focus on expanding local food production and processing, and traditional foods and processing to offer opportunities for a flexible, resilient food system that is resistant to shocks and can also offer a healthy diet and immune functions.

6. Bring together all partners, inter-disciplinary, governmental and non-governmental resources, to work together to improve the resiliency of the food systems, to withstand food chain disruptions with the acknowledgement that Food Science and Technology is included as an effective and important partner. Using the Penta Helix approach, government, industry, academia, community and media would all be brought together.

Section Three:
STRATEGIES AND CONCLUSIONS

Delivering future resilient and sustainable food systems must include acknowledgement at policy levels of all areas of government that food science and technology must be incorporated into education leading to capacity building, food and nutrition, research and development that impact regulatory, social and economic facets of government, and partnerships in every sector including the empowerment of women. General acknowledgment that health and wellbeing of a population and a healthy diet are not based on nutrition alone but also on the transformation of the food systems to be sustainable and resilient which requires the expertise of food scientists, technologists and engineers who are involved from farm to the consumer. The vital contribution of the profession to increasing flexibility of manufacture, tailored to local ingredients, thereby producing better nutrition at acceptable cost is an example. India, the only country with a Ministry of Food Processing Industries adopted the interdisciplinary approach during the COVID pandemic over the past year that ensured that food shortages were not faced in any part of the country and food was not imported. This is only possible with planning, execution with digitization and traceability. Small and medium industries were still involved at local levels to manage the procurement from the national grid and delivered through small shop outlets as the large bazaars were all closed. Reaching out to the villages was not an easy task with a 1.4 Billion population spread across 4000 km north to south and 4000 km East to west. This could serve as a model other countries could emulate to transform their food systems.

Specificity to the major areas in which Food Science and Technology is an essential partner for healthy and resilient future food systems includes involvement in government policy making, some of the reasons have been cited here. Secondly Food Science and Technology expertise is essential in providing the technical expertise for further development of the food industry from local to multinational, including new and innovative technologies to improve nutrition value, immune function, availability and variability of a balanced healthy diet. Food Science and Technology is crucial at all levels and needs to be recognised by all for its role in assisting agriculture through processing at the local levels to help communities gain self-sufficiency and achieve stable and nutritious diets.

Capacity Building through Research and Development, Education and Training Needs that can be fulfilled through the application of food science and technology together with other partners from the local to the international levels is crucial. Specificity regarding some of the areas in which international food science and technology through IUFoST networks are necessary is included in the Brief included in this report on *Education and Training for Capacity Buildin*g. Skill development through capacity building is essential to

ensure stable and resilient food systems from farm to table through Food Science and Technology training. Responsible research, innovation and good ethical approaches all need to be utilized. Education at all levels – governments to consumers – is urgently needed to teach the essential role of food science and technology in food and nutrition security and safety.

Food Processing is often misunderstood. Many governments and consumers have no clear idea of its importance; from enhancing and maintaining traditional food systems through local processing and how to reduce losses in storage systems. Many do not know that a key to improving the food security problem is through food processing. Knowledge of processing helps to reduce post-harvest losses and economic strains by developing new technologies for food and nutrition. A further Brief submitted here in this report details some of the challenges and solutions from the perspective of *Traditional Foods and Processes* that international food science and technology in which IUFoST though its scientific networks can continue to be an important and effective partner with others.

Sustainable food packaging requires inter-ministerial and inter-departmental interaction. Cooperation in each country and region is essential between disciplines as access to, sufficiency of, and reduction of food losses and wastage impacts every sector of governance at all levels, and as Food Science and Technology is the only direct link from farm to fork, it needs to be part of all discussions and actions. Future Food Systems will be linked to climate changes and food crises occur through extreme weathers, which result in scarcity of food, food price escalation and shortage of ingredients for a healthy diet.

Food systems involve all processes related to food - from the production, processing, and distribution of food, to its preparation and consumption. When these systems suffer from imbalances, such as the lack of access to healthy food and supply of food of poor nutritional quality, with misleading information, people start to eat in an unhealthy way. Consequently, the population's health is affected, and this may end up becoming a global problem. The obesity epidemic, caused by this imbalance, has grown alarmingly in recent years and this is causally related to the increase in cases of cancer and other chronic non-communicable diseases, such as high blood pressure and diabetes. To remedy this undesirable situation, which will continue to worsen if not controlled, it is necessary to invest widely in scientific research and in effective public policies that reach the largest number of people possible, as well as a holistic education in Food Science and Technology, that provides a technical basis for how changes can occur and how to mitigate food production's adverse effects on the environment and increase nutritional value of local and global foods.

In the context of mobilisation of inter-disciplinary collaboration, The International Science Council (ISC) (in which IUFoST was elected by its inter-disciplinary peers and is the only representative of global food science and technology) in February 2021 invited IUFoST to deliver two presentations during its General Assembly week. The discussions centred on *Interdisciplinary Collaboration to Sustainable, Adaptable and Healthy Future Food Systems***.** Speakers, including members of other ISC Unions, agreed that Food science and Technology is central for nutrition and food security across both rich and poor countries, at primary, secondary and tertiary levels, for sustainable livelihoods. Using local solutions for global replications have provided a focussed approach for IUFoST. Sustainable actions, strategies and pathways for adaptable, accessible and affordable food and nutrition security have to be clearly firmed up with capacity building, infrastructure as well as human resource. All these facets of science and technology underpinning IUFoST work bring together Food Science, Nutrition, Biology, Agriculture, Forestry, Fisheries, Information Technology and the Science of Climate Change at large.

Nutrition, Biology, Agriculture, Forestry, Fisheries, Information Technology and the Science of Climate Change at large

Food and nutrition insecurity are greatly influenced by changes occurring in the climate globally, which are largely man-made. The magnitude of the world problem of feeding itself and its interface with climate change /environment and energy problems have led the United Nations to convene this Food Systems Summit in 2021. It offers a remarkable opportunity to revisit many of our short-range objectives as well as long-range goals and give a mid-course correction in the context of Global warming. These will also bring in a large number of challenges and opportunities for many actors and IUFoST can network, synergize and catalyze cooperation and collaboration between many global organizations.

This will also set the policy actions and strategies and set priority areas to focus upon in the pre-harvest and post-harvest conservation and in food processing with adaptable, affordable, and accessible technologies with modern and traditional adaptation. This need- based information, dissemination of knowledge, capacity building, continuing educational training, communication and mobilization, and taking up fast track research and development are important and a priority both for IUFoST and the United Nations against the backdrop of global warming. Its reversal may take several decades to see the changes. Food production is the most vulnerable and severe shortages of staples can cripple the world.

The interdisciplinary collaboration as a focus area, for sustainable, adaptable and healthy future of food systems, is in fact, one of the prime agendas for the UN System Summit. Evidence-based solutions for resilient future food systems require coordination and interdisciplinary work from the farm to table. Prevention of food losses, food waste, use and development of traditional foods, new and emerging processing, scale up of R& D, immune boosting foods, training the trainer and capacity building all form the cornerstones of IUFoST work.

SUB-SECTION 1.1
FOOD AND NUTRITION SECURITY: TRADITIONAL FOOD AND PROCESSES – Towards a Healthy Diet for all

FOCUS AREA BRIEFS *included here on Traditional Food and Processes and Food Science and Technology Education and Training for Capacity Building provide further specificity of the importance of Food Science and Technology for sustainable and resilient future food systems, as the Science is represented in 13 of 17 Sustainable Development Goals and in all Action Tracks for the Food Systems Summit.*

INTRODUCTION

Traditional foods offer an equal opportunity to every nation to contribute to the issue of global sustainable and resilient world food systems for all nations have their own traditional foods that are part of the culture of the people. Traditional food processing techniques date back to ancient times and constitute a vital body of indigenous knowledge handed over from generation to generation. Traditional foods have sustained livelihoods over centuries, feeding local populations, sustaining health, showing resilience, and moreover, in many cases, contributing to traditional medicine. The knowledge, standardization and scaling up of processing of traditional foods is fundamental to preparing future food systems to withstand shocks as recently occurred with the global health pandemic and the disruptions of food chains. Traditional food safety practices will continue to provide practical and local solutions for

future food systems. Using a multi-disciplinary approach and bringing together experts from various scientific backgrounds, with global diversity, Food Scientists and Technologists and Engineers are focussing their attention more closely on how food interacts in the human body for delivering health and wellness.

In addition, the future of a healthy diet requires further understanding of consumer interests and preferences (local culture on diets and food consumption behaviours) as we have seen them looking for 'healthy alternatives' even more actively during the recent health crisis and yet fewer options have been available to many. The COVID 19 pandemic demonstrates that local traditional foods rich in nutrients and bioactive compounds strengthen resiliency against disease and improves immune systems. As well, the economic fragility of nations often comes from food crises, whether because of high costs or scarcity of food. Now is the time for sustained research and development of foods including scaling up the processes for the production of traditional foods.

There is a need for scientific understanding of how traditional foods have sustained diets over centuries including documenting immune functions of the foods and the nature and strengths of traditional food processing techniques. The operations need to standardize and improve the quality and safety of the products.

Traditional food systems use cultivated crops that are locally available in each region. Different food preferences, food habits, and consumption patterns have developed through the years. A resilient food system must be put in place to accommodate changing food habits through appropriate food processing methodologies, adequate access to local raw materials, development of nutritious food recipes using various technologies, and ensuring good quality and safe food products. The value chain of locally cultivated crops should be adequately studied. Examples of such crops include yam, sweet potato, millets, pulses, legumes, tubers, spices and herbals, among others. Climate impact could also be monitored by erecting more greenhouses and the use of modern scientific tools that would ensure the sustainability of traditional food systems.

Traditional foods and traditional food processing can be a 'game changer' as part of the solutions to sustain resilient and healthy food systems. International Food Science and Technology, represented by IUFoST, provides opportunities for government at all levels, market players, local and multinational industries, academia including food scientists, technologists, engineers, environmental and climate scientists, agriculturists, nutritionists, biologists, geologists, hydrologists, social scientists and others to use existing knowledge and skills to build greater sustainable and healthy foods in the ever-changing environmental, political, economic, and social dynamics.

CONSULTATIVE MEETINGS

Priorities with regard to traditional foods and future food systems were identified through a series of consultative meetings across disciplines, with International Science Council members, national scientific members of IUFoST and its disciplinary and regional groupings.

The priority is to create, adapt and improve technologies to address issues of lack of sustainability and safety of food from farm to table. It was established that processing technologies need to be improved, adapted, and developed to address issues of the lack of sustainability of traditional food products; to standardize them, establish their safety and to scale up for large-scale commercial production for local, regional and global markets. It was agreed that international food science and technology through IUFoST and its partnerships can promote traditional foods and processes towards healthy diets for all.

Food Science and Technology plays a central role

Food Science and Technology plays a central role, supported by governments and R&D, in actions working across disciplines to:

- Document available raw materials, good agricultural practices, good hygienic practices and measures to reduce post-harvest losses and food wastes.
- Promote adaptation and improvement of traditional foods and processes, while respecting the traditional, ethical, cultural and religious aspects involved and supported by total diet studies related to these parameters.
- Develop sustainable and flexible food processing technologies that can be scaled up as needed.
- Develop food packaging materials and processes that will extend shelf life, reduce waste, and are sustainable and economical.
- Improve food systems and food and nutrition security through capacity building and dissemination of knowledge.

Some examples of existing traditional foods and processes available that can strengthen future food systems with the benefit of more research, development, and appropriate technologies:

- Miso soup in Japan is a proven example of contributing to healthy diets and the traditional food Kimchi in Korea and foods from China and India, South East Asia, the Mediterranean and Central and South America.
- Many traditional African fermented plant-based foods and condiments such as “dawadawa”, “ogili”and “ugba” are rich in bioactive compounds and nutraceuticals with health-promoting benefits. Even though considerable amount of research has been done on improving the quality of African traditional foods, including studies on the nature of the substrates (agricultural raw materials) and the fermenting microorganisms (largely lactic acid bacteria and yeasts), they remain largely at the bench scale. The lack of pilot plant facilities for scaling up research from bench scale to large-scale commercial production is the most important constraint to commercialization of research findings and upgrading African traditional foods. Given, the huge cost of modern food pilot plant facilities, the establishment of zonal or regional food pilot plants in Africa by governments or the private sector will improve traditional foods and processes, promote the commercialization of research findings from African universities and research institutes, and advance the cause of food science and technology in Africa.
- Herbal drinks from China have a proven role in boosting the immune system and thereby preventing disease and improving health. Food scientists, technologists and engineers can use this knowledge, together with their understanding of how food and the human body react to each other. This will also pave the way for the industry to deliver traditional foods using sustainable processes.
- The northeast part of India is characterized by diverse populations with different ethnic backgrounds. Indigenous and fermented foods are an intrinsic part of the diet for these ethnic groups. It is one of the oldest and most economical methods for the development of a diversity of aromas, flavors, and textures as well as food preservation and biological enrichment by manipulation of different microbial populations. There are more than 53 traditional knowledge-based immunomodulatory plants in the state of Manipur in India and more than 100 plants in the state of Assam in India. Detailed studies of the nutritive and medicinal value of these can provide valuable information and are well documented.
- Many fermented foods are region-specific and prepared according to the region and therefore unique and deeply attached to the social fabric. Scaling up this knowledge would benefit and reach larger populations. Food Science and Technology expertise can play a key role in identifying nutritional and health benefits of the products and scale-up.

REACHING EVIDENCE-BASED FOOD SCIENCE AND TECHNOLOGY ACTIONS AND SOLUTIONS

Traditional spices and herbs have been used from time immemorial to promote good health and as medicines and they are being acknowledged for their immune-boosting functions. Scientific documentation needs to be brought together and shared with the medical profession, nutritionists, sociologists, and other scientists as well as the consumer.

Traditional foods of some regions remain unknown as potential food sources in other parts of the world. Through capacity building, such products can be introduced in future food systems into new markets. There are opportunities available for innovation through an understanding of traditional raw materials, ingredients, and processes. Industries can learn more about market needs around consumer preferences for healthy, environmentally acceptable, and socially friendly food products that are available economically, provide local employment, and through local sources that help to promote a healthy diet. Consumer preference can be guided through education by the lessons of the traditional food products, processes that provide safety and sustainability for the food systems.

Food Science and Technology has a central role to play to guide traditional, indigenous crops, through local technology processes that have been established through centuries in local kitchens and marketplaces to scale them up with the use of appropriate technologies. More research should be focused on the components of traditional foods, and processes related to the environment (soil, climate, water resource). Traditional processes for scale-up and adaptation to other localities need to be explored. Appropriate food engineering approaches, and standardization, in conjunction with cultural and environmental reference-points, would ensure the safety of the traditional foods.

Traditional Foods contain principal technological routes to reduced energy utilisation in processing: natural preservation; retention of micro-nutrients; and a wide variety of acceptable tastes and textures. All of these are technologies transferable into new product forms anywhere. As such they represent the basis of sustainable innovation, without the regulatory and consumer concerns associated with high tech novel processing.

Experts representing food science and technology in the areas of fortification, food safety, food processing and product development, production and market economy, human nutrition, food engineering, and quality control would work with partners in agriculture, animal breeding, and genetics, livestock processing, social agencies, government regulatory bodies, and UN agencies, including CODEX. Capacity building and collaborative research efforts are required from governments and must include industry engagement; overall a cross-discipline engagement is needed with food science and technology as the coordinating component to ensure the safety and sustainability of the traditional food chain.

There is a critical need for women to be educated in Food Science and Technology as they are the drivers in agriculture, traditional food production and processing in many parts of the world. Market gardens and informal markets are led by women. Women empowered with knowledge of food safety and processing teach others in the marketplace and informally with their families, thereby establishing a sustainable scientific understanding of food and will help direct consumer demand and the demand for a healthy diet.

Local evaluation of markets and assessment of food safety aspects, availability, and suitability of training programs should occur on an ongoing basis and understanding food science and technology is crucial. Upgrading traditional foods is critical and the engineering and technology and market challenges and safety are all factors to be considered. To upgrade locally produced traditional foods and allow research on all aspects of food production from farmer to consumer, food pilot plants are a necessity in

the chain if an impact is expected. This need is particularly urgent in many parts of Africa and Asia. Traditional food systems have many ingredients and processes that require standardization of research and technology to ensure food safety. These pilot plants are a necessity at the local and regional levels.

Besides the primary role of food pilot plants, an interesting example of the adaptability of a Food Pilot Plant during an environmental disaster is the case of the Central Food Technological Research Institute in Mysore, India. When the Tsunami hit South Asia in 2004, the Research Institute and the Pilot plants converted themselves into production centers of retort pouched foods and dehydrated foods suitable for the region of Southeastern India for nearly 10 days, transported in an organized manner to the disaster-hit areas in the east coast of India beginning within 24 hours of the disaster. The Institute had this wide experience helping in earthquake-hit areas, high altitude foods, and also in floods and hurricane seasons to prepare the traditional foods applicable to the affected local populations. This is a clear model that can be reproduced everywhere in the world as an added value where governments support and maintain adequate food pilot plants that have the resources to respond to their communities and country in the event of a food-related crisis.

Documentation of indigenous and local food thereby building resilience by including available techniques is required. The existing systems need to be valorized regarding their specific socio, climatic and economic conditions. Packaging, transportation, and markets need to be analysed.
Value additions need to be identified and digitalization will be needed to build the architecture and documentation with coordination between UN agencies and International Science Council Unions and other partners. Mobile technologies have an increasingly large presence in many countries and can be utilized in this regard.

Taste is a fundamental factor to be considered in the scale-up of traditional food products as the consumer will not eat food that is not as it is remembered in the traditional process or if it does not taste good. Food processing techniques have to consider the expected demand by the consumer. Food scientists, technologist, and engineers must develop processes tailored to suit the specific markets, the socio and economic backgrounds and the underlying requirement for safety and sustainability.
The solutions would be driven by academic labs and food pilot plants cooperating across diverse cultures – local, regional international partners in government, policymakers, national scientific bodies, individual industry at all levels, scientists, academia, students. Public-private partnerships and governmental agencies directed specifically at food as well as agriculture and nutrition are essential components.

Safe, sufficient, and nutritious foods are the basis of a healthy diet. The future of food systems requires the development of all aspects of food, from raw material to processes with consideration of environmental impacts and education regarding human consumption habits. Traditional foods offer the baseline to improve and provide a healthy and sustainable food system.

This goal cannot be achieved without food scientists, technologists, and engineers who can document the health benefits of the foods that promote immunity from disease. To analyze the components of the foods to determine the safest way to grow the raw materials (crops), cooperation together with scientists in other disciplines to ensure most sustainable growth, feed, and nutrients, to continue to develop the safest and most effective way to transport crops, process the traditional food to maintain the traditional flavor and nutrients is needed. To scale up production to reach larger populations and to scale down in the event of future disruptions in the food chain, inter-disciplinary cooperation is required.

SUB-SECTION 1.2

FOOD SCIENCE AND TECHNOLOGY EDUCATION AND TRAINING FOR CAPACITY BUILDING

BACKGROUND AND ROLE of IUFoST

The three main tenets of the International Union of Food Science and Technology (IUFoST) which represents food scientists, technologists, and engineers globally are Education, Food and Nutrition Security and Food Safety. To carry out its mission, IUFoST works with the Food and Agriculture Organization (FAO), World Health Organization (WHO), United National International Development Organization (UNIDO), CGIAR (Consultative Group on Agriculture Research), IFPRI (International Food Policy Research Institute) and many other R&D establishments, academic institutions, industry, non-governmental and governmental organizations, and its national adhering bodies worldwide.

The objectives of IUFoST are the encouragement and fostering of:
a) international cooperation and exchange of (scientific) knowledge and innovative ideas among food scientists, engineers and technologists at a global level.
b) progress in the fields of theoretical and applied food science and technology and food engineering for improvements in the processing, manufacturing, preservation and distribution of food.
c) education and training of food scientists, technologists and engineers.
d) development of both individual professionalism and professional organization among food scientists, technologists and engineers for safe, secure and sustainable technologies globally with local application.

Specifically, the objectives are measured against the 2010 IUFoST Cape Town Declaration as follows: "Essential to the Declaration is the right of every individual to have access to adequate and safe food. IUFoST delegates recognise the indispensable role of food science, technology and engineering in achieving these aims of eliminating food insecurity worldwide. IUFoST members, who are the national scientific organisations worldwide working within the Union, outlined the primary areas of work for food scientists, technologists, and engineers in the Cape Town Declaration: Included in the outline is "education in nutrition, food science, engineering and technology at all levels".

IUFoST represents and directly and indirectly links more than 300,000 food scientists, technologists, and engineers from its network with organizations in more than 100 countries and five regional groupings: Europe (EFFoST), Latin America and the Caribbean (ALACCTA), South East Asia (FIFSTA), Western Africa (WAAFoST), and the Middle East and North Africa (MENAFoST). IUFoST Disciplinary Groups representing Nanotechnology, Functional Foods and Nutraceuticals, Food Engineering, Water in Food, Food Microbiology, and Food Research, all contribute to the depth, breadth, and impact of IUFoST's work.

CONSULTATIONS, WORK PROGRAMS AND ACTIONS IN EDUCATION

The General Assembly of IUFoST meets regularly to determine priorities and the work being done in capacity building and education. The need to develop capacity and to mobilize the workforce to create and sustain future food systems is agreed upon among the scientific community of food science and engineering. This begins with fostering education and training at every level as life-long exercises. A key component of this is train-the-trainer activities that will allow local instructors to present material to groups in their own language or dialect.

Consultations with partners in food science and technology, other related disciplines, government agencies, and academia have resulted in ongoing programs initiated at the country level with IUFoST national scientific members. These include educational programs at all levels÷ within the formal educational systems (primary, secondary, post-secondary, MSc and Ph.D. levels). In addition, technical programs have been designed and developed for those employed in the food industry without formal secondary school certification. IUFoST Symposia, such as the Myanmar Food Safety symposium for small and medium-sized businesses (SMEs) address specific issues at both country and regional levels. Mentorship programs are employed globally spearheaded by the Fellows of the International Academy of Food Science and Technology (IAFoST) and many IUFoST partners to provide individual expertise and leadership in information fora, as well as guidance for educators and students at national and regional levels. These have been identified as Visiting Professorship programs, amongst other mentorship activities.

The Food Safety Education series in South East Asia, South America, and Africa have been a partnership among governments, academia, and industry. They have been focussed by request on regulators, nutritionists and health professionals, the consumer, and media. In China, IUFoST has an ongoing partnership with the government, academic institutions, the national scientific body, and International Science Council representatives in presenting annual fora for media and industry. The main thrust is discussing the issues behind food safety, food, and nutrition security from the perspective of sound science.

The mobilization of youth is key to ensuring food and nutrition security through capacity building. Enhancing the level of knowledge of food industry workers and those in the retail food sector can be accomplished by providing educational material that can be taught by individuals who participate in a train-the-trainer program provided by IUFoST. Teaching the importance of food science and technology beginning at the pre-school level and throughout every part of the system is urgently needed. Numerous programs are underway. Particularly successful achievements in this regard are demonstrated throughout India with classroom learning in science and chemistry of food from the pre-school level that the children receive. In parts of Africa, the Rural Outreach Africa program is successfully teaching girls about local raw materials (crops), harvesting, handling, processing, and marketing through school programs that provide for their whole communities. In China, there are Taste Literacy programs that embrace the teacher, classroom, home, and business together community by community. These need to be emulated.

THE CRITICAL ROLE OF IUFoST and FOOD SCIENCE AND TECHNOLOGY IN CAPACITY BUILDING

Food Science and Technology and Food Safety programs in colleges and university programs in Singapore, for example, provide an essential learning component that empowers young people and sends the students to less-developed communities in the Association of Southeast Asian Nations (ASEAN) to assist with food safety and food processing of local foods. Knowledge of and replication of successful programs aimed at or for young people, girls, and women all need to be disseminated more widely and employed more universally as applicable. Empowerment programs, and involvement of students in training programs from farm to table all need to be initiated country by country. This has been a key part of the IUFoST success in developing Food Safety curricula as requested and recognized by the World Bank in the Global Food Safety Partnership initiative. IUFoST consulted country by country, and region by region in developing a curriculum that could be used as a standard for post-secondary food safety education. It is still being refined and undergoing further development as it begins a rollout in

conjunction with national scientific members and the FAO. Training of Trainers (ToT) is a way to expand capacity building in an effective way. This can be further enhanced if the training material can be made available to a wider group in easy-to-understand formats, which are readily accessible at any time. One such example is the Small Industries Development Organization (SIDO) work in this regard in Tanzania.

These initiatives need to be stepped up to provide educators and industry professionals with the required updates in their lifelong education. This will encourage them to learn the latest in innovations, safety and technology around food, food safety, food and nutrition security, and to lessen food waste and losses. Certification programs need to be tuned in countries and supported by governments and academics in partnership.

"Capacity Building and Mobilization" includes implementing a beneficial application of a multidisciplinary approach of Food Science, Technology, and Engineering to improve food systems,
secure capacity building, and build resilient food systems which are locally available. A collective approach of professionals in the areas of food, nutrition, and public health that come together to
promote safe food and healthy diets for all and draw upon the expertise of professionals can be organized. This helps take a holistic approach to food and nutrition through cross-fertilization of ideas among professionals of different disciplines. Such an educational network can be envisaged as a self-sustaining model functional at national, state, city, and rural levels to adopt and implement activities to address the needs and issues in a coordinated phased manner.

PREPARING FOR THE FUTURE

Now is the time to begin preparing for the future. It can be done using a peer-to-peer approach or using an experimental site for demonstration of the principles and technology involved. Successes can then be replicated. Multinationals and national companies in food value chains need to be mobilized to incorporate increased consumer awareness and sensitivity to global issues of sustainability and poverty reduction as well as the over-arching need for capacity building and employment generation.

Rural communities in many countries are affected by the lack of enough schools and health and welfare facilities with the system over-stretched by population. Therefore, there is inherently less knowledge about nutrition, general hygiene, food processing and health-related issues. With the current global warming and resultant extreme weather events, they are adversely affected by either unseasonal droughts or floods. As a result, in some of these extremely impoverished countries affected by water scarcity, it is difficult for them to grow food and preserve it for the rest of the year. Lack of know-how and poor knowledge will prevent them from even preserving what they grow, resulting in heavy losses. "Globally, about a third of all food is lost or wasted every year, accounting for a quarter of the calories that would have been available for human consumption" (International Food Policy Research Institute, IFPRI 2017). This also includes high-Income countries that waste food since food is affordable but the consumer needs educating on the waste and losses that affect everyone (HLPE Report, FAO 2014). In a world where 1 in 9 people go hungry, food losses and waste are urgent issues for hunger-reduction. Food safety concerns, such as aflatoxin contamination, are also a major concern due to the health risks they pose from exposure. Lack of awareness and incentives to improve safety standards is another concern. Without improvements along the value chain, consumers and smallholder farmers are hindered from fully benefiting from high-quality nutritious foods available for their consumption and for the market.

FURTHER ACTIONS THAT NEED FOOD SCIENCE AND TECHNOLOGY AND ENGINEERING EXPERTISE

In order to facilitate the dissemination of food science, technology and engineering, the following actions are proposed:

1. Continue to develop cross-sector collaboration among businesses, policymakers, citizens, and academics to execute capacity building and developmental projects.
2. Provide advice and know-how, show-how, and do-how with a focus on successful projects by the local population. It is important to recognize cultural practices of food management and the varieties of foods grown in different seasons within a region to help spread nutrition over the whole year. IUFoST understands this well through its fellowship across all the continents and, therefore, can help prepare the human resources to meet the needs of the region, while maintaining the rigor and benchmarking the training in these areas. Scientific knowledge can bridge the effect of consumer behaviour and cultural diversity in supporting healthy diet patterns by conducting total diet studies in that particular area or region.
3. Increase education programs as they form a part of "capacity building" in the broad sense. Food-related education spans a wide spectrum of audiences, from young to old (pediatrics to geriatrics), village-level training to tertiary education. It can cover disciplines such as food production, packaging, distribution, safety, security, nutrition, health and sustainability, plus affordability and marketing. It has also to embrace a wide range of disciplines such as Industrial Management, Information and Communications Technology, Artificial Intelligence, Robotics, etc.
4. Provide ongoing information sources based on science. For example, booklets produced during training on utilization of traditional or novel foods also serve as tools of capacity building. Digital resources with cell phone accessibility in the local language will need to be increasingly utilised as the majority of the people at the ultimate receiving end of capacity building in the above programs end up contributing to the economy both, directly and indirectly.
5. Training and re-training the trainer by helping young faculty (and in food pilot plants) with certifications and re-certifications to improve standards, enhance food safety, and build capacity is important.
6. Government ministries should work in concert with food scientists, technologists, and engineers in the development of skills centres and industries at large. For example, Senegal has a Ministry of Handicrafts. Tailoring government ministries to assist in the education and capacity building for youth and all those in the food sectors will mobilize resources and create capacity, and ultimately economic and social development as well.

The ICN (International Conference on Nutrition 1992) was an historic process on which IUFoST built its mission. It is understanding that capacity building encompasses the entire food chain. The magnitude of the problems must be examined. Our position is to continue to maintain and develop further realistic and effective strategies, to increase public awareness of the needs, and to mobilize the financial~~,~~ capacity building resources in addition to keeping a system in place for monitoring the effectiveness of the education and training. For example, important work could be accomplished with the African Union through national scientific bodies and other partners in food science and technology to expand the knowledge base on food safety, nutrition, and security. This solution could be employed with the support of the National Academies of Science. Everyone has to be invested in the future and knowledge transfer is the basis for securing a safer, more resilient food system.

Information exchange, training, local technology, social issues, equipment, security, and quality all require education input from food science and technology. Good hygienic practices~~,~~ and good manufacturing practices have education and effective communication at their core. The failure to understand the cause-and-effect relationships create food safety issues. Knowledge transfer to women

and to local cooperatives and informal markets will reduce the vulnerability of the food systems. The community outreach education programmed including students and faculty can train the trainer or those handling food from village to multinational industry. Training and education must include understanding of farm conditions, soil conditions, challenges of processing and distribution in order to develop a sustainable and safe food chain. Some examples of the educational needs that can be met with the help of food scientists, technologists, and engineers continuous support to microbiological safety and storage~~,~~ stability, which are critically determined by water in foods (for example, control of microbiological hurdles). This requires a detailed understanding of the effects of processing, formulations and distribution for sustainable food systems in the food chain.

IUFoST would continue to link projects in a synergistic way. IUFoST could network with other groups, such as the South African Confederation of Agricultural Unions (SACAU) on cassava processing for example. Containerized food processing of bitter cassava and adding capacity for value through food processing can be brought into a rural community rapidly. This would provide food and jobs. Novel aspects could be explored with a unit operating in a sustainable mode~~,~~ close to energy and water autonomies.

Resource and data collection to facilitate education strategies and behavioral change to promote healthy sustainable diets and food systems need to be expanded to a global resource base. JIFSAN (U. of Maryland, USA) working with the FDA is rolling out programs related to traditional markets to reduce food safety risks. Partnerships such as this can be enhanced with national scientific bodies in food science and technology and the educational expertise present. For example, in Nigeria, the IUFoST national scientific body Nigerian Institute of Food Science and Technology regularly conducts workshops in the informal markets on food safety. They create a chain of educational know-how that reaches all corners of Nigeria. The development of a knowledge base that uses new and innovative technologies, artificial intelligence, robotics, and digitalization all need to be developed through appropriate partnerships with the core competence of Food Science and Technology.

The key objectives for global Food Science and Technology (through IUFoST) are:

1) Actively support various flagship programs of governments on food and nutrition,
2) Engage with academic, research, and higher education institutions to build capacity,
3) Engage with food businesses to ensure availability of safe and healthy food,
4) Create demand for safe and healthy food through a social and behavioral change of citizens,
5) Expand the knowledge base of the profession through collaboration and cross-disciplines,
6) Enable further growth of the associations and professional development of their members.

The intended result of these actions is to prepare a skilled, highly qualified agri-food workforce for the future. This can be accomplished through primary education in food, food processing and distribution, and nutrition. They will improve health and well-being in homes and communities which will provide a healthy future workforce. These actions will also provide teachers and training-the-trainer programs related to the future food industry directed towards tuned and sustainable food systems through equitable education programs in Food Science and Technology from the grassroots.

APPENDICES

APPENDIX 1 – Examples

LOCAL, REGIONAL and COUNTRY- LED INITIATIVES around Food Science and Technology

Examples: 'Brasil Mais' Program in Brazil: Partnership between Ministry of Agriculture, Livestock and Food Supply (Mapa), through the Secretariat of Brazilian Cooperatives (OOB) and the Inter-American Institute for Cooperation on Agriculture – mentoring between cooperatives related to business skills – markets, management, governance and process improvement.

Brazilian Network of Food Banks – strategies to organise public, private and civil society initiatives to reduce food waste through regional and national integration.

Brazil Ministry of Health provides guidelines and elaborations for good food and healthy eating – demystifying doubts about food and nutrition, ten steps towards healthy eating for Brazilian children – Healthy Academy, Activity Book, Physical Activity Recommendations, Brazilian regional foods and short version of Food Guide for consumers.

Novel Local Solutions in Northeast India for Minimization of Food Losses and Waste for a Sustainable Food System, India.

Post-Harvest Technologies Developed by CSIR-NEIST, India.

An Improved Grain Storage Container, - a traditional devise used in North Eastern part of India, is scientifically improved in the design to minimize the losses of pulses / food grains due to high humid conditions, and replacement of traditional pesticides with herbal pesticides based on local resources, to minimize the losses – can be replicated with local resources in similar climatic conditions.

Nigeria Tertiary Education Trust Fund (TETFund) Research and Development Standing Committee (Agriculture Thematic Group): a new initiative on agricultural research and development in Nigeria. (September 2020). The mandate of the Agriculture Thematic Group is to aggregate research and innovations in agriculture for enhancement of value addition and agribusiness towards improvement of food and nutrition security for health, poverty reduction and improved national resources management.

The Nigerian Federal Government on June 4, 2020 announced a new programme in agriculture called "Green Imperative" which is to "revolutionize agriculture in Nigeria." It is a Nigeria-Brazil Bilateral Agriculture Development Programme worth $1.2 billion to be implemented over a period of 5-10 years with funding from the Development Bank of Brazil (BNDES) and the Deutsche Bank. "The Programme will eliminate post-harvest losses, create 5 million jobs and inject $10 billion into the economy within 10 years.

As an example of success, a research and development programme sponsored by the UK government successfully linked local companies in India with a multinational manufacturer. This produced nutritional snacks derived from local commodities and side streams, in a form recognisable and acceptable to local consumers.

EDUCATION

Examples: Study programmes dedicated to sustainable food systems – introduction of undergraduate degrees focussed on 'sustainability'.

Development of tools to contribute to understanding and transfer of knowledge about sustainability concepts for students and teachers – (secondary).

Modules related to sustainable entrepreneurship for master's level students.

Development of a "One health" approach among all stakeholders towards sustainability, safety and health.

University network for Sustainable Development – including subgroup on food.

Community based education projects, example Rural Outreach Africa and China Taste Literacy outreach.

Training the Trainer programmes expanded – from communities, factory floor, for those without formal education in food science and technology, food safety, further development of mentorship programmes between students and experts

Continuation and enhancement of the global food safety education curricula together with FAO, country partners, universities and others

Introduction/encouragement of digital learning opportunities for competence training in food related fields

EMERGING & EXISTING TECHNOLOGIES

Examples Food Waste/Food Loss

Low-cost technologies for cold storage of fresh produce and transportation (i.e., solar powered cooling systems) to handle surplus harvest.

Introduction of micro-farming concept as a robust means to increase urban food security (collaborations with agronomists, crop scientists, soil scientists, etc.).

Systematic quantification of food loss and waste and valorization of food wastes and by products-upcycling (collaboration with process engineers, material scientists, etc.).

e.g., fruit juice processing industry waste-extraction of pectin and fibres.

India example of local adaptable solution: **:** The storage of food grains is very difficult in Northeast India, due to prevailing high humidity (>80%). A major portion of the grains produced by the farmers in traditional storage structures results in a substantial loss of food grains (7% to 15%). The existing traditional storage systems were modified incorporating the scientific knowledge and keeping traditional wisdom, for safe storage of grains, which could on a pilot-scale reduces the losses to < 2%. On a national and global level this saving can be substantial.

Multiple examples from *Mathys et al* related to sustainable food processing from a system-oriented approach in food production by including the total value chain and society's emerging needs and their environmental, economic and social impact. (see Appendix A).

Examples Food Safety

Food contamination and traceability systems/surveillance and monitoring systems-improved frequency of testing for food authentication and quality assurance by collaborating with data scientists (big data approach to cover the farm to fork continuum).

Developing an integrated system for mapping the flow of ingredients and products throughout the food supply chain until reaching the consumer-with an ultimate objective of reducing food loss and waste by an optimisation approach (collaboration with data scientists and technology experts).

Use of IoT-enabled systems/blockchain for food safety monitoring (collaboration with data scientists, computer network specialists and other technical experts).

RURAL AND EMERGING ECONOMY SUPPORT

Examples: Mozambique and Tanzania have a wide range of subtropical and tropical fruits and vegetables. During the season, there is an over-abundance of them and more than 60% of the fresh produce is lost due

to lack of processing facilities. There is also a lack of 'know-how' for rural folks to start cottage industries. These problems are common to most developing countries.
In some of the developing countries in the South Pacific, South East Asia and Africa, at the rural community level, the farmers and cottage industry entrepreneurs are unable to implement their ideas and desires because they lack finance and capital; technology and know-how; a steady supply of raw materials; processing facilities and equipment maintenance; manpower and good management systems and access to markets.

It is important to identify such opportunities and create cottage-industries in rural areas that the local people could easily manage without highly qualifies professionals and without the use of sophisticated equipment. Such projects should be supervised and monitored until they become 'mature' and self-sustainable. In order to develop sustainable and affordable healthy food systems especially in the rural communities, we must first enable those communities and support the production of traditional products and processes they are familiar with by providing micro-finance, improvements to traditional methods, basic hygiene and food safety practices and packaging and storage facilities.

A fundamental part of any strategy towards more productive and sustainable agriculture, food processing and rural development is access for agricultural and food producers to markets with better efficiency, transparency, and competitiveness.

APPENDIX 2 – IUFoST Background

IUFoST is the International Union of Food Science and Technology, the global scientific organization and voice for food science and technology supporting programmes and projects to increase the safety and security of the world's food supply. It represents directly and indirectly more than 300,000 food scientists, technologists and engineers working in over 100 countries. IUFoST is the only global representative body of Food Science and Technology elected by its scientific peers into the International Council for Science (ICSU), now called International Science Council. (ISC).

IUFoST responds to worldwide needs with education programmes; scientific expertise; global leadership; knowledge exchange through publications; programmes to improve the safety and sufficiency of foods around the world; and reduction of physical and nutritional losses in the food value chain.

- Promotion of the safety and quality of all foods
- Adaptation and improvement of traditional foods and processes, while respecting the traditional, ethical, cultural and religious aspects involved
- Beneficial application of science and technology
- Development and dissemination of improved knowledge of food composition
- Facilitation of domestic and international food trade
- Development of food materials with improved functionality
- More efficient and environmentally sustainable food production, processing and packaging
- Education in nutrition, food science and technology at all levels

IUFoST uses a multi-disciplinary approach to achieve its mission, aims and objectives.

APPENDIX 3 - General References, Support and contributors

- IUFoST Declarations (Budapest and Cape Town)
- Reports of IUFoST General Assemblies
- IUFoST and the Global Food Safety Partnership: World Bank initiated contract for IUFoST to prepare standardized global curricula in Food Safety. Regional, global meetings with multi-disciplinary partners
- National and regional meetings with academia, industry and government around education, food safety food and nutrition security (example CODEX meetings, curricula development with partners in China, Ireland, Colombia, Argentina, Lebanon, Kenya, Vietnam, Indonesia and others)
- Food Safety Symposia series and related meetings with industry, government and academia

Consultations

- IUFoST Food Systems Summits 1 and 2
- Summit 2 Technical Working Group Members (inter-disciplinary)
- Task Force on Food Systems and COVID-19
- Scientific Roundtable Discussions (inter-disciplinary)
    - Climate Change and Food
    - Food Losses and Food Waste
    - Food Processing
    - Sustainable Food Packaging
    - Extraordinary Series related to COVID 19 and Food Systems 1) China 2) Africa and Middle East and 3) Supporting the Resilience of the Food Production Sector
- National Scientific Members of the International Union of Food Science and Technology (IUFoST)
- Academy of Food Science and Technology (IAFoST)
- IUFoST Board of Directors
- Academy Council Officers
- IUFoST Scientific Council Officers
- Chairs and Members of IUFoST Working Groups, Standing Committees
- Panelists and contributors to Scientific Roundtable Series
- Rural Outreach Africa
- Taste Literacy China
- Colleagues in the International Science Council (ISC) and CODATA
- Other collaborating international organizations

Publications

- *The science of food security*, Science of Food (a Nature journal) 2018: Martin Cole, Mary Ann Augustin, Michael Robertson and John Manners.

- *Multi-indicator sustainability assessment of global food systems*, Nature Communications 2018: Abhishek Chaudhary, David Gustafson, Alexander Mathys.

- *Food safety issues in fresh produce supply chain with particular reference to sub-Saharan Afr*ica, Food Control 2020: O. Charles Aworh.

- *Global missions and the critical needs of food science and technology*, Trends in Food Science and Technology 2020: Anne-Marie Hermansson and Peter Lillford

- *IUFoST/CIFST Hold an Extraordinary Scientific Roundtable on COVID-19 and Food Safety*, Science of Food (a Nature Journal) 2020: Gerald G. Moy

- *Does COVID-19 Affect Food Safety and Security?* Journal of Food Bioactives, 2020; Fereidoon Shahidi

- *Concepts of Small-scale Food Processing*, Royal Society of Chemistry 2021: Donald. G. Mercer

- *Integrating Science to Address Food and Health Within the Global Agenda 2030*, Science of Food (a Nature Journal) 2021: Gordon A. McBean

- *CFS – HLPE Report on Food Losses and Waste* (2014)
- CFTRI Annual Reports
- CSIR Annual Reports

For specific titles, references and further information, please contact IUFoST Secretariat at secretariat@iufost.org.

Other IUFoST Briefs including Food Processing – A necessary fundamental for sustainable resilient food systems and a healthy diet – and Sustainable Food Packaging - are available as requested by the Scientific Group of the UN Food Systems Summit