

Sustainability of Food Systems: The Role of Food Technology and Regulatory Science 03003

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Sustainability of Food Systems: The Role of Food Technology and Regulatory Science

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Abstract. Food systems encompass complex and interconnected networks involved in the production, processing, distribution, and consumption of food. Currently, the food system confronts significant challenges related to the environment, society, and economy. A 2023 joint report by FAO, IFAD, UNICEF, WFP, and WHO underscored the major obstacles impeding the achievement of the Sustainable Development Goals (SDGs) within the food system. The report emphasized the challenges associated with meeting the needs of the growing global population. These challenges, particularly in addressing hunger, are exacerbated by rapid population growth, resource scarcity, climate change, the impact of COVID-19, and conflicts. Recognizing the imperative need to transform the food system towards sustainability to fulfil the dietary demands of the expanding global population, the pivotal roles of food technology and regulatory science in addressing these challenges were highlighted. It's essential to prioritize the development and promotion of food technology innovations, especially for micro- and small-scale food producers, to enhance the safety, quality, nutritional value, shelf life, functionality, accessibility, affordability, diversity, and appeal of food, thus promoting healthier dietary practices. Moreover, the crucial role of regulatory science was emphasized, specifically in formulating and enforcing regulatory and policy frameworks conducive to fostering innovation and ensuring alignment of the food industry with the SDGs. Both food technology and regulatory science are indispensable components in facilitating the transformation towards a sustainable food system.

1. Introduction

Talking about the food system, reference to the report published by the FAO, UNICEF, IFAD, WFP, and WHO regarding the global food security situation in 2023 is very relevant.

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The report emphasizes the strain on our current food system, highlighting a significant challenge of the current food system, which is especially related to the fact that too many people in the world live in hunger, as depicted in Fig. 1.

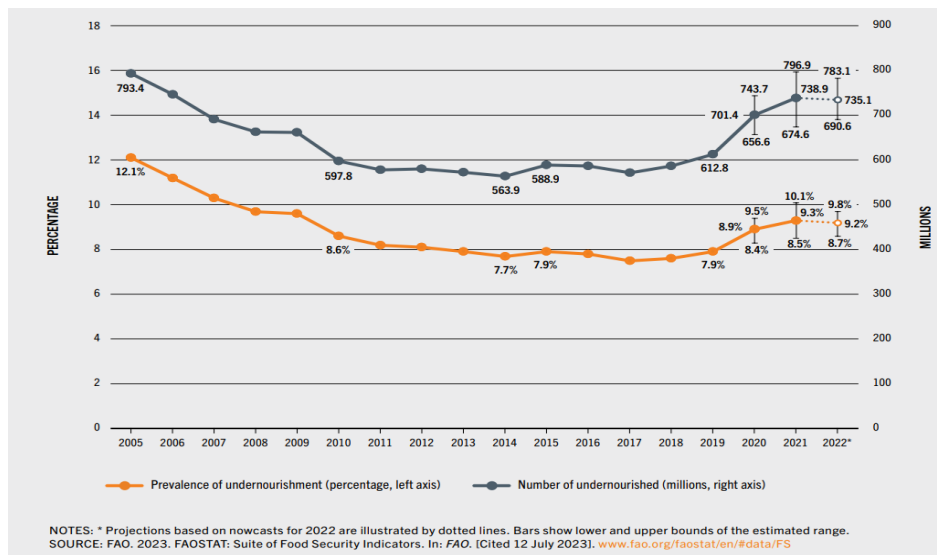


Fig. 1. Global hunger of the world is alarming [1].

As clearly presented in Fig. 1., global hunger, measured by the prevalence of undernourishment (PoU), remained high in 2022, affecting about 9.2 percent of the world population. The PoU spiked in 2020 due to the global pandemic, and increased slightly in 2021, before levelling off from 2021 to 2022. In 2022, about 735 million (691 million - 783 million) people in the world suffered from hunger. This was an increase of 122 million people compared to 2019, before the pandemic. Moreover, the report emphasized that over 2 billion people experience micronutrient deficiencies, while obesity and diet-related non-communicable diseases are increasing. This alarming situation emphasizes the urgent need for action to achieve the zero-hunger target and ensure that the food system can sustainably feed the growing world population.

To tackle these challenges, the report suggests a comprehensive approach that acknowledges the connections and trade-offs between various components and participants of the food system. According to the High-Level Task Force on Global Food and Nutrition Security (HLTF) of the United Nations [2] a food system is defined as “a system that embraces all the elements (environment, people, inputs, processes, infrastructure, institutions, markets and trade) and activities that relate to the production, processing, distribution and marketing, preparation and consumption of food and the outputs of these activities, including socio-economic and environmental outcomes”.

Furthermore, the report FAO, IFAD, UNICEF, WFP and WHO [1] also recommends a series of policy measures to promote more sustainable, resilient, inclusive, and healthy food systems across the rural-urban spectrum. Sustainable food system is defined by the UN-HLTF, [2] as “a food system that delivers food and nutrition security for all in such a way that the economic, social and environmental bases to generate food security and nutrition for future generations are not compromised”.

Indonesia, as stated by the Minister of National Development Planning/Head of National Development Planning Agency [3] as Head of State Statement at the United Nations Food

Systems Summit New York, September 23rd, 2021, is of the view that strengthening the agriculture sector is crucial for food system transformation. The statement also mentioned that Indonesia is committed to create a more inclusive, resilient, and sustainable agri-food system.

This is not an easy task. It should be realized in advanced that the transformation of the food system to be more sustainable must take into account several additional challenges, such as (i) decreased availability and quality of arable land, (ii) limited water supplies, (iii) competition for biomass for renewable energy, (iv) the unpredictable effects of climate change, and (v) unsustainable lifestyles.

2. Roles of food technology

Institute of Food Technologist [4] defined food technology as the application of food science to the selection, preservation, processing, packaging, distribution, and use of safe food. While food science is defined as the study of the physical, biological, and chemical makeup of food; the causes of food deterioration; and the concepts underlying food processing.

As defined, food technology plays a crucial role in changing food systems to make them sustainable and promote good health. A publication by the World Health Organization (WHO), authored by Motarjemi et al. [5], recognizes that food technology is important for ensuring that food is safe and suitable to eat. Food technology also helps to prevent food from spoiling easily and becoming contaminated, making it safer for consumption. This, in turn, ensures that there is enough food to prevent people from going hungry or becoming malnourished. Food technology can simplify cooking for everyone, including women, allowing more people to take part in productive economic activities. Implementing suitable food technology also improves the taste, texture, and overall sensory appeal of food, providing consumers with a wider range of choices that cater to their preferences and way of life.

Overall, several key roles of the food technology in this transformation of food system, are the following:

- (i) Enhancing food quality and safety, reducing waste, and improving nutritional value and taste.
- (ii) Increasing food diversity and accessibility, catering to various preferences and needs, and making food more affordable and available in remote areas.
- (iii) Reducing environmental impact by using resources more efficiently and minimizing waste and pollution.

Applications of appropriate food technology also have important socioeconomic implications. They facilitate and promote trade in food and may also empower small-scale producers through improved efficiency, transparency, and provide access to markets. Empowering the food industry, especially small and micro-scale producers, is crucial for Indonesia. According to the Central Bureau of Statistics, in 2020, there were 1,619,472 food industry units in Indonesia. Only 7,263 of these units were classified as large or medium-scale food industries (IBS), with the rest being small or micro-scale (Fig. 2). This means that small and micro-scale industries make up 99.55% of the total, emphasizing the necessity for specific food technology to support their growth.

Supporting the growth of the food industry, especially the small and micro-scale sectors, is essential to ensure the well-functioning of the food system, enabling the production of sufficient quantities and varieties of safe and nutritious foods for the growing world population. The food industry (where 99,55% are micro- and small-scale producers) plays a crucial role in establishing effective links between production and consumption, mitigating

nutrition insecurity by supplying safe, nutritious, functional, affordable, socially and culturally acceptable food for nourishing the population.

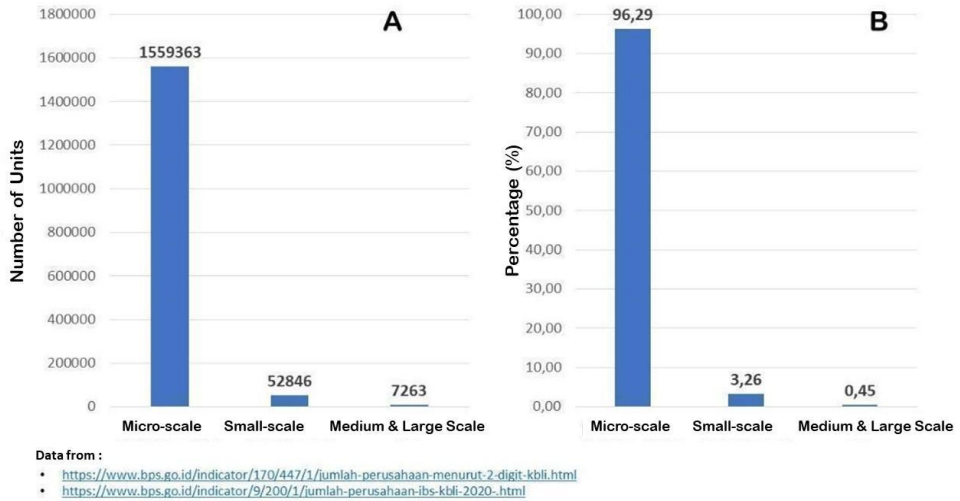


Fig. 2. The condition of the food industry in Indonesia, based on business scale, in units (A) and percentage (B). Source: BPS [6].



Fig. 3. Food processing industry serves as an essential link between production and consumption sides.

In fact, it is undeniable that for centuries food industries have been contributing by doing food processing, starting from old versions of food technology such as fermentation, salting, preservation, drying, smoking, et cetera. This activity of food processing, converting raw

material to safe, nutritious, and edible food were able to meet their daily needs, and advance civilization up to now.

In this regard, food technology (or food processing technology) plays a crucial role in enabling the growth of the food industry, particularly for small and micro-scale sectors. Applying food technology in a context-specific and participatory way can help these sectors improve their performance, competitiveness, sustainability, and resilience within the global food system. Empowering and supporting the growth of small and micro-scale food industries is crucial for Indonesia, given their significant contributions to the country's economy, employment, and food security (see Fig. 2 and Fig. 3).

In the field of food technology, the focus should be on adapting and advancing the indigenous/traditional food technology, including indigenous fermented-food technologies of Indonesia: These traditional methods, utilizing microorganisms, such as tempeh, soy sauce (*kecap*), fermented cassava (*tape*), and fermented buffalo milk (*dadih*), contribute, not only to the preservation, but also to the enrichment of nutritional and functionality of food. Indonesia is rich in diversity of nutritious indigenous foods that are culturally accepted across various local areas. Food technology can help preserve and promote traditional knowledge and biodiversity, while enhancing their quality, safety, and market presence.

Indonesia is also rich in food culture based on local resources. Unfortunately, some of which are underutilized or even neglected. Food technology can identify, characterize, enhance, and promote these resources such as sago, moringa, breadfruit, and other locally known foods. By improving processing methods like fermentation, drying, and encapsulation, it can boost their value, functionality, and marketability, while minimizing waste. Additionally, it can raise awareness among consumers and policymakers and support small-scale industries in utilizing these resources.

Food technology also plays a vital role in discovering and evaluating new food resources, including insects, seaweeds, and other local edibles. Food technology should be used to transform these resources into appealing, consumer-friendly products that meet demand for safety, variety, quality, and convenience. Additionally, food technology should be used to educate consumers, producers, and policymakers about the benefits and potential of these new food products. These will be significant in facilitating transformation of the food system toward more sustainable, environmentally, and also economically.

Generally, the main roles of food technology (food processing technology) as applied in food processing industry, include:

- Ensuring the safety of food products,
- Minimizing the decline in, maintaining, or -sometimes- improving nutritional quality,
- Adding nutrients (fortification, enrichment, etc.),
- Extending shelf-life (ensure safety, prevent spoilage),
- Provide practicality and convenience,
- Provide palatability and sensory quality,
- Provide options by developing new products,
- Ensure better food safety,
- Improving efficiency and reducing the cost of food production, processing, packaging, and distribution,
- Minimizing food waste, and
- Promoting food diversification, providing more options for consumers and encouraging healthier dietary practices.

3 Role of regulatory science

In addition to the role food technology, the transformation of the food system toward a more sustainable one also requires the role of regulatory science. Regulatory science is particularly necessary to scientifically guide the work of all stakeholders/actors in the food system, especially the food industry sector, in contributing to the transformation toward a sustainable food system.

Specifically related to FDA-regulated products, FDA [7] defined regulatory science as the science of developing new tools, standards, and approaches to assess the safety, efficacy, quality, and performance of all products. In more general terms, regulatory science is defined as a science-based decision-making process of regulation development, including development of tools, standards, and other measures. Meaning that applications of regulatory science ensure that food regulatory measures are based on the best available scientific knowledge and evidence.

Hence, in the field of food industry, application of rigorous regulatory science, will results in evidence-based regulation that can scientifically guide the food industry, not only to ensure (i) safety, nutrition, and quality to protect consumer health, but also (ii) sustainability to safeguard environmental well-being, and (iii) continuous innovation and alignment with the sustainable development goals (SDGs). Exploration and management of new food sources – for example- will be associated with new types of risks requiring regulatory tools beyond what is currently available. This will be delivered with the development of relevant regulatory science, supported by well-educated, detail-oriented and up-to-date regulatory scientists, with mastering the holistic problem-solving skills and strategic thinking, and collaboration inter- and trans-disciplinary.

In the global context, the Codex Alimentarius Commission, an international food standard setting body established by the FAO and the WHO, serves as a regulatory science model. Codex standards are a set of international food standards, guidelines and codes of practice that aim to protect the health of consumers and ensure fair practices in food trade. Codex standards are based on the best available scientific knowledge, using risk analysis principles to assess and manage risk associated with risk of hazards in food.

Risk analysis is a structured approach that consists of three components: risk assessment, risk management and risk communication. Risk assessment is the scientific evaluation of the probability and severity of adverse health effects from exposure to a hazard. Risk management is the process of weighing policy alternatives and selecting appropriate measures to control the risk. Risk communication is the interactive exchange of information and opinions among risk assessors, risk managers and other interested parties. Codex standards are recognized as a model of good applied regulatory science and can be used as one of the principal guidance for the transformation of the food system, especially on the aspect of food hygiene, contaminants, nutrition, labelling, and specific standards for different food categories.

Applying regulatory science can help address the criticism that the food processing industry has faced in recent years, especially on the negativity and criticism surrounding processed food. Society has increasingly held a negative perception of this industry. There is a widespread perception that the more food undergoes processing, the unhealthier it becomes. This perception is not favourable and presents a real challenge for the food industry, in contributing to the transformation of the food system.

As the food industry is a vital part of the food system (see Fig. 3 and 4), criticizing it without offering guidance can adversely affect the performance of the entire food system. However, the criticism should be viewed as a challenge and food technologists and the processing industry community should respond by taking a more active role in demonstrating their responsibilities. They should enhance their efficiency and effectiveness in fulfilling

their crucial role in the food system, transforming raw materials into safe, nutritious, functional, affordable, and socially and culturally acceptable food products. Additionally, the food industry should persist in innovating to enhance sustainability across production, distribution, and consumption.



Fig. 4. Food (processing) industry is an essential component of the sustainable food cycle [8].

For instance, the food processing industry has faced criticism for its contribution to the rise of non-communicable diseases, particularly overweight and obesity. This is particularly pertinent in the case of processed foods, where the excessive use of sugar, salt, and fat is a significant concern. With the implementation of effective regulatory science, the food industry can be scientifically guided and play a role in addressing the obesity epidemic. One strategic approach involves reformulation, wherein the industry modifies its food products to enhance their safety and healthfulness by reducing fat, salt, or sugar content, incorporating nutrients, specific functional ingredients, and proteins, sourcing more locally, or even eliminating allergens. Notably, the World Health Organization [9] has issued a policy brief on reformulating food and beverage products for healthier diets, offering guidance to the food industry on product reformulation.

4 Conclusions

The food system grapples with a significant challenge of malnutrition, ranging from hunger and micronutrient deficiencies to obesity. Despite progress, the prevalence of undernourishment remains markedly higher than pre-pandemic levels, impacting between 690 and 783 million people in 2022. Transforming food systems necessitates sustainable approaches to feed the growing global population, while addressing the environmental and social impacts of food production and consumption. This entails not just increasing food production, but also enhancing the quality, variety, and accessibility of food for everyone.

The food industry, a vital segment of the food system, utilizes raw materials to create safe, nutritious, functional, and affordable food that aligns with social and cultural norms. This process contributes to sustainability by reducing waste, preserving, and improving nutrition, and providing cost-effective options for healthy diets. With processed foods being a crucial part of modern diets, reformulation is imperative to promote healthier eating habits. Food technology plays a pivotal role, particularly in ensuring the safety, quality, nutritional value, shelf life, functionality, accessibility, affordability, diversity, and appeal of food, thereby fostering healthier dietary practices. Additionally, regulatory science plays a critical role in implementing evidence-based regulations to ensure consumer health and safety, promote environmental sustainability, and encourage continuous innovation in alignment with the Sustainable Development Goals (SDGs). Both food technology and regulatory science are indispensable in facilitating the transformation of the food system towards sustainability and improved health. In any food-related profession, it is our responsibility to guarantee the safety and nutritional value of the products we create, sell, and promote to consumers. Safety is a foundational principle in the food industry, as it safeguards the health of consumers.

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