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Research Article

Employing Engineering Principles and Business model innovation in Food Systems to Achieve Sustainable Development Goals

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Abstract

A food system encompasses all of the processes and infrastructure involved in ensuring a population's food security, including gathering/catching, growing, harvesting, storing, processing, packaging, transporting, marketing, and consuming food, and non-production aspects. It also incorporates socioeconomic and environmental factors. Food security can be expanded to include nutritional characteristics based on diet diversity, such as vegetables, fruits, meat, milk, eggs, and fortified meals, in addition to typical metrics of calorie availability. Environmental, nutritional, and socioeconomic challenges in the globalized agro-industrial food system are at the center of political agendas, reform initiatives, and sustainable curricula in higher education institutions in order to hasten the transition to food sociotechnical systems. Engineering is a strong field of study that combines a variety of information and abilities founded in science and technology to function successfully and deliver real-life answers to human needs. Food engineering, as a component of the global food system, bears a special duty to society. It has several uses in food systems such as food processing, storage, packaging, distribution, food security, and transportation. Integrating sustainable development goals with the application of engineering principles in food systems and food engineering principles allows for food security and poverty alleviation.

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Introduction

The production of food encompasses planting, harvesting, handling, storing, processing, preservation, packing, distribution, and marketing. It is one of the largest and oldest industries in the world. Over time, small, family-run companies have expanded into big, integrated food supply chains that are getting more and more sophisticated. This transition has been prompted by growing urbanization and the dependence of sizable segments of the populace on pretreatment, preprocessed, or ready-to-eat, secure meals. Enhancing efficient mass production and delivery of food supplies is more important than ever. The food sector has grown in response to these demands, necessitating the support of numerous, well-rounded teams of scientists, engineers, economists, and marketing specialists.

Over the past few decades, environmental concerns have been raised about the long-term sustainability of the globalized agro-industrial food system, which refers to the ways in which institutions, agriculture and farmers, food industries, and consumers organize their practices to produce, prepare, and consume food products [1]. These worries range from socioeconomic issues like rural poverty and the vulnerability of small farmers to environmental issues like air pollution, species diversity, ecosystem integrity, increased food miles, and intensive livestock production to nutritional and health issues linked to improper food consumption and unhealthy diets.

Today, the repercussions of these concerns and solutions are front and center on the political agenda, reform programmers and future goals and scenarios [2-4]. They propose for an 'ecological transition' through innovation that develops and disseminates clean technology while also initiating larger changes in sociotechnical systems [5]. These changes aim to ameliorate the economic, nutritional, and environmental consequences of the world's dominant industrial food system, as well as to change consumer behavior and even the meaning of what they eat.

Starting an environmental transition motivates players to eco-innovate supply chains and reduce the lifecycle environmental impacts of food items by lowering the social and production costs associated with conventional agriculture and food processing [6]. Implementation is slow in the agri-food industries due to a lack of capabilities and competencies required to operationally execute the Sustainable Development Goals. It must be included in the activities, structure, and governance of business models when reengineering food items using eco-innovation practices [7].

Despite increased research on a wide range of issues concerning sustainable engineering [8], more study is required to supplement our understanding of the systemic nature of eco-innovation and the role of business model innovation. As a result, there has been justified worry in recent years about the effectiveness of the application of engineering of food principles with sustainable development goals. Given this context, this article examines the integrating of sustainable development goals with the use of engineering principles in food systems and the application of food engineering principles in ensuring food security and poverty alleviation.

Materials and Methods

This review report was generated by exploring the literature for available scientific material and relevant literatures on Food engineering; Food systems; Resiliency; Nutrition security; Business model innovation for food systems; Sustainability. The following databases searched extensively: PubMed, Cochrane Controlled Register of Trials, Ebsco, Scopus, and Web of Science. Plus Google Scholar and ProQuest for grey literature were searched. The peer review of electronic search Strategies [9] and the PICOS (population, intervention, comparator, outcome, and study design) aspects in our search approach. The English-language publications published between January 1983 and December 2022 was considered. Similarly, the reference lists of the retrieved papers for further relevant material was searched. The most recent search was conducted in April 2023.

Application of Engineering of Food to Build Resilient Food Systems: The use of engineering in the food system (chain) may include in area of designing food processing equipment to meet standards; bulk handling and food production; speed and effective use of production time,; safety and labor economy; hygienic production by reducing biological/human contact; effective transportation of farm produce within and outside the production premises; It aids in the effective storage of food items; it aids in the effective disposal and management of waste; effective cleaning and sanitation can be achieved by engineering application; and it promotes operational flexibility.

Food (Process) Engineering: Functional engineers in the food industry, on the other hand, must be familiar with biological and chemical sciences as they apply to the food industry, such as sanitation, food shelf life extension, public health, environmental control, and biological process engineering, in which microorganisms are used to drive or mediate processes to produce food materials or products. In consequence, a food engineer is a science generalist rather than a specialist in one field. Because foods are made up of a wide range of physically and chemically complex materials, they must be studied on a micro-scale through disciplines such as biochemistry, microbiology, or food chemistry, or on a macro scale through thermodynamics, transport phenomena, rheology, or heat transfer. Food engineers analyze issues pertaining to food production, food quality, process and plant design, and food regulation in academia, government, industry, and as private consultants [10,11].

Food engineering is a critical link between farms and food outlets in the modern civilization's life support system. Small, independent, and nonintegrated food production systems can no longer meet the modern world's food requirements. The logistical challenges and complexities of feeding a globe where many countries are unable to produce enough food have prompted a demand for a more science- and engineering-based strategy. Future food engineers will push forward the development of computational methodologies as tools for process automation, control, design, and improvement [10,11]. High hydrostatic pressure, pulsed electric fields, light pulses, oscillating magnetic fields, and ultrasound are examples of novel technologies that have the potential to effect non-thermal processing preservation. Food engineers will take the lead in incorporating such processes into the actual architecture of industrial facilities, along with barriers that will assist in retaining the nutritional and sensory aspects of safer natural food items.

Food Industry and Engineering: Food engineering, as a specialized technical profession, is no longer seen as a promising career path. Indeed, food corporations, increasingly driven by quarterly profit reporting, no longer consider food process engineering as central to their operations [10,12]. Over the last 50 years, the desire for lower-cost food production methods has also propelled other production cost-cutting methodologies like as Six Sigma (6), lean manufacturing, Kaizan, and so on. Although powerful tools for increasing manufacturing efficiencies, they are primarily based on incremental improvement and do not embrace either the need for radical change or the innovative skill set that a food process engineer considers to be his or her primary role.

Whereas previously, taste, price, and convenience were the primary drivers of food growth and profitability, new emerging drivers now include health and wellness, safety, social impact, and experience, with transparency becoming an overarching driver on all counts [13].

Because modern food and beverage manufacturing processes are exceedingly sophisticated, they involve all unit operations, mass, and transport phenomena across all materials. The same could be said of chemical process engineering, which is why it is becoming more popular in the food business. It should be highlighted, however, that the natural home of food engineering is not in the chemical engineering field, but rather in its agricultural roots and raw material supply.

Food Engineering is a technical multidisciplinary profession that deals with the system and structures of food, production processes, as well as physical, (bio) chemical, and biological transformation processes [14]. It is founded on scientific rules as well as economic, ecological, social, cultural, and religious values.

The Covid-19 pandemic has taught the globe that we also need to establish an integrated approach that includes both land-based agriculture and food engineering disciplines, as well as food science specialists, to lead to a more integrated, sustainable, and secure food supply chain. A single voice representing all food stakeholders must persuade the government to provide large-scale financing opportunities for future food research, as well as the ability to develop new food production systems to deliver the same at scale.

According to core competences, when it comes to reengineering food systems. For more than two millennia, food (process) engineering specialists have led progress in the food business. They are ideally positioned to lead and create both essential innovation and new manufacturing methods. Food process engineers are already aware of these facts. A global web survey of the food engineering profession conducted in 2016 addressing upcoming challenges in the food sector, ranked the following key areas in terms of priority [10,15]: (i) A more inventive profession that promotes entrepreneurship and broadens activities; (ii) A broader/better applicable education that can be applied in food/and other industries; and (iii) More professional chances to serve mankind. The most difficult problem for food process engineers and our profession in the future will be convincing the rest of society that, from an economic, social, and/or political standpoint, the current food model must alter course.

Engineering and Sustainable Development Goals: Nations throughout the world have committed to activities to combat poverty and hunger, among other concerns, through the seventeen Sustainable Development Goals (SDG). The SDG targets are demonstrated by the fact that the lives of several millions of people in various parts of the world are threatened by hunger. Food scarcity affects around 116 million people in Asia and Africa. To achieve zero hunger, clever application of technology and engineering principles and solutions is required [2].

Food Engineering Technology to Build Resilient Food Systems, and Improve Food and Nutrition Security: All of these problems stem from the reality that, whether considered from an economic, social, or political standpoint, food availability has always been about meeting a basic human need rather than simply increasing shareholder returns [12].

We are currently and will continue to face significant global problems in terms of food and nutrition security. According to general estimates, food systems will need to deliver safe, affordable, nutritional, socially and ethically acceptable foods to around 10 billion people worldwide by 2050. Furthermore, we must do so in a sustainable manner: we must cut and optimize our use of resources such as food, energy, water, and land. Indeed, many of the United Nations' sustainability goals are tied to food systems.

Current food systems are highly integrated/globalized and have poor robustness, which means they are vulnerable to both local and global stresses like economic, political, and natural upheavals and disasters. Stresses to food systems are predicted to continue in the (near) future, such as pandemics, economic shocks, and local and global climate change effects. As a result, it is critical to construct resilient food systems to withstand future disturbances and reduce food and nutrition poverty. Solutions to these complex and dynamic problems are obviously not simple and necessitate the participation of many sectors as well as a comprehensive approach.

In terms of food systems, some broad solutions include: designing more sustainable procedures that consume less energy and water and produce less/zero waste. Valorization of byproducts, byproduct streams, and "waste" Food shelf life should be extended. Food nutritional profile enhancement; Reduce the usage of highly processed and dry ingredients in favour of more functional and sustainable options [10,12]. Novel and sustainable raw material sources, such as proteins and additives; Shorter and more resilient food supply networks; and Building strong local/regional food systems.

Disseminating food engineering-based solutions to construct sustainable and resilient food systems and promote food and nutrition security. Such solutions could include:

Manufacturing Solutions Include novel and emerging non-thermal technologies, process intensification, shelf life extension, processing and valorizing byproducts, side-streams, and waste, utilization of regional raw materials, and process sustainability evaluation.

Nutritional Solutions include nano-encapsulation, smart packaging, structure, salt, sugar, and saturated fat reduction, the use of less pure and more complex raw materials and additives, and the use of innovative protein sources.

Supply Chain Solutions include supply chain sustainability assessments, system engineering studies, and the management of concentrated, less refined, and stable substances.

Contributions in this collection include a wide spectrum of the solutions described, providing examples of relevant approaches to attaining the established goals.

A comprehensive overview of the advancements and future prospects of novel processing technologies for improving plant protein quality and characteristics [16]. Traditional thermal (intense) processing is used in general, although some drawbacks include lengthy and energy-intensive procedures, significant water consumption, and losses of valuable chemicals in the final product. Instead, several developing technologies, including ultrasonic, microwave, supercritical fluids, pulsed electric field, high-pressure, ohmic heating, cold plasma, and enzymatic processes, have been examined.

These technologies can be used alone or in combination to improve process efficiency. Emerging technologies are non-thermal or executed at low temperatures/short periods, presenting a promising balance between processing practicality with low environmental effect and increased nutritional features and protein techno-functionalities. The authors emphasize the broad scope of these emerging technologies for achieving adequate quality of plant-based proteins, but they caution that more research is needed, particularly regarding protein digestibility and amino acid composition of plant proteins when using such technologies. Finally, it is discovered that the practicality of industrial application requires more development at larger sizes than those accomplished in the laboratory.

In a review article about the current situation and opportunities of wastes arising from fruits and vegetables (availability, characterization) as potential sources of valuable ingredients (fiber, polyphenols, pigments), suitable to be incorporated into food, pharmaceutical and cosmeceutical products [17]. Fruits and vegetables lead the ranking of food wastes and losses, e.g., 40–50% of their production; this current problem can be seen as an enormous opportunity to design strategic resilience plans for the recovery of valuable compounds in a circular economy framework. In particular, peels, pulps, pomaces, and seed fractions of fruit and vegetables can be suitable raw materials for the recovery of different bioactive compounds, including fiber (pectin, prebiotic oligosaccharides), polyphenols, and pigments. The authors also discuss sustainable and feasible extraction/obtention technologies to valorize wastes, which depend on the particular compound. They highlight the need of translating efforts made at laboratory scale to industrial processes, in order to effectively take advantage of these cost-effective raw materials. On the other hand, it is claimed that valorization of fruits and vegetables by products will not only contribute to environmentally sustainable practices but also to creation of dynamic and competitive regional economies, especially in developing countries and rural environments. Finally, the authors analyze the benefits of implementing a circular economy strategy to develop supply chains, especially for companies, considering a comprehensive concept of sustainability, from environmental to financial and social aspects.

The present a research article about the impact of ultrasound-assisted freezing on the flavor, microstructure, and myofibrillar proteins of large yellow croaker, an important marine cultured fish widely distributed in China [18]. It is well known that freezing is an efficient method to extend the shelf life of foods by controlling microbial growth and decreasing biochemical reactions, but the quality of frozen fish depends on the freezing method (i.e., freezing rate). Therefore, several innovative and emerging freezing techniques have been proposed to provide a promising solution to optimize the crystallization of frozen fish. In this study, the authors evaluated five different freezing treatments: air freezing; immersed freezing; ultrasound-assisted immersed freezing (UIF) linked with single frequency at 20 kHz (SUIF); UIF linked with dual frequency at 20/28 kHz (DUIF); and UIF linked with triple frequency at 20/28/40 kHz (TUIF). Results indicated that multi-frequency ultrasonic treatment (TUIF) efficiently improved the flavor attributes and characteristics of myofibrillar proteins of a large yellow croaker. The authors concluded that multi-frequency ultrasound-assisted freezing can serve as an efficient way to improve food quality and nutritional profile in a sustainable way.

The development of a sustainable film based on Polylactic Acid (PLA) with incorporated Nhalamine compound (MC), as a promising antimicrobial food packaging material for fresh produce [19]. N-halamines are a group of compounds containing one or more nitrogen-halogen covalent bond(s); this high-energy halide bond provides a strong oxidative state so that it is able to inactivate microorganisms effectively. Polylactic Acids (PLA) have compostable properties and also comparable mechanical properties as Polyethylene Terephthalate (PET) and Polystyrene (PS). Therefore, the authors grafted MC onto PLA resins, in order to obtain an antimicrobial food packaging film with satisfactory mechanical strength and transparency. The developed PLA-MC films showed high transparency, strong mechanical strength, thermal stability, water vapor barrier, and oxygen permeability properties. Films of PLA with 0.25% MC inactivated seven logs (complete inactivation) of S. aureus and E. coli within 30 and 5 min of contact, respectively. In a pilot study, strawberries wrapped with MC-incorporated films extended their shelf life to at least 5 days at room temperature. The authors concluded that due to the ease of fabrication and the effective biocidal property, these films have a wide range of potential applications in the field of food packaging to extend the shelf life of fresh produce.

Food Systems

Food (raw or processed) is materials orally consumed by humans or animals for growth, health, and satisfaction. In the conversion of food into edible form, many stages are usually involved. It is the description of all processes involved in food production. The food system involves various areas of food materials, ingredients, food processing, operations, food preservation, distribution, and availability [20]. There is a strong connection between effective food systems and food safety. Effective engineering applications in various stages and operation of food system obviously will help food security.

Type of Food Processes: Irrespective of the final form of a food product, several steps are involved. The stages of production and processing depend on the final form of the product (wet or dry), consumer preferences and standards [21]. Processing of food products often begins with sourcing for raw materials.

Food raw materials (primary, secondary, or tertiary) are put into a processing operation to achieve a desired product. Sourcing exercises are usually achieved in the industries by the sourcing/procurement department. The sourcing procedure includes cleaning, sorting, grading, quality assurance and storage [20]. Food raw materials can be classified into four major categories: The unprocessed agricultural produce, semi- processed agricultural products, finished products and the by-products.

Unprocessed Agricultural Produce: They are in natural unprocessed form as harvested from farm (tubers, fruits and vegetables, grains and cereals, raw meat, poultry).

Semi-Processed Agricultural Products: They are partially processed either for temporary storage purposes or distribution for subsequent use.

Finished Products: These are finished products from other industries. These finished products may be raw materials from another company.

By-Product or Effluent: It is possible that the by-product in an industry can serve as input for another industry.

It is expected that sourcing exercise should aim at obtaining the best quality of raw materials at a most economical rate. In order to achieve this Sourcing officer is expected to have: (i) Sound and dependable knowledge about the raw material. These nature or properties must be considered in the form of their unique properties (biological, physical, chemical, mechanical, thermal, optical, rheological and others) of the raw materials. (ii) The understanding of classes of the food with their required nature and handlings is necessary in raw materials sourcing. The raw material sourcing officer must understand the required standards and processing operation the raw material will undergo before getting the finished product. (iii) Raw material sourcing official is expected to be well acquainted with the standards and specifications required for a quality product.

Industrial Food Processes: In the food industries, there are production of raw food materials to edible product. The sensory and texture qualities, nutritional composition and health benefits are expected to be intact. Production of food may involve several unit operations [20] The application of engineering principles in various unit operations are inevitable.

Unit Operations are unique stages in the production of food products. These operations can stand alone and when studied, embody many engineering principles. The industrial production of food requires a food plant which must be properly designed. Applications of engineering principles in the food processing and industries are in diverse forms, however relevant in small, medium and large scale food production. The processing space is determined by the plant size, the food products, quantity and demands.

Food Plant Layout: Food production requires sequence of unit operations [20]. Industrial food production requires organized manufacturing environment, where needed combination of applicable unit operations are strategically positioned. This is achieved by well-intended plant layout. Designing of effective food processing environment and operations is expected to include process description, pilot plant, testing, facilities, equipment layout, process control and sanitary design [22].

Plant layout is the strategic arrangement of structures, machines, facilities, offices on the industrial site, this aids effective, smooth flow and safe operation. The effective arrangement create unhindered accessibility of the personnel, transportation of material in and out of the plant. Plant layout helps to enforce proper management of materials and ensure conformance to standards. With effective plant layout design, the possibility of minimum movement, space utilisation, flexibility of operation and proper supervision of staff and activities is encourage. [21,23]. Thorough analysis of facility infrastructure, process, materials, equipment, personnel storage, logistics and other related processes are often needed to achieve effective plant layout.

Classification of Food Processing Stages

There are varieties of food processing equipment in food industries. The final product, operation and application usually affect the choice of the applicable equipment. The arrangement of the equipment in the food industry may be product based or process based. In the preparation stage, some common unit operations may be employed. The types of unit operations are determined by materials and the product [20]. The employed equipment in the processing can be classified into equipment for preparation, processing (mechanical or manual), heat application, preservation, packaging, transportation and distribution.

Food Preparation Operation: Several unit operations are usually employed in the processing of food. It is not compulsory that all unit operations mentioned here may be relevant for producing a product. In the preparation stage, the cleaning, sorting, grading and peeling are usually important [10,12,20].

Cleaning: Depending on the raw material and the source, there may be need to remove foreign contaminants and unnecessary parts. This can either be done by dry (air classifiers, magnetic separators and screening separators) or wet (floatation tanks, soaking, spray washing, washing systems, sterilizing and ultrasonic cleaners) processes.

Sorting: Sorting process can be manual or with the aid of machines. This operation is useful in separating food materials based of specified parameters and sometimes may function as cleaning operation (removal of foreign matters and contaminants. Sorting separates food materials based on a measurable physical characteristics (size, shape, weight, or color). Sorting machines, disc separators for shape sorting, sieves/screens for size sorting, machine vision sorting systems and sorting conveyors are mechanical means, developed to aid sorting operation.

Grading: is like sorting. It is used in assessing several characteristics of food like flavor, damages, skin color, aroma, etc. to determine the overall quality. Tungsten lights (candling), image processing and sensors have found applications in grading procedure.

Peeling: is the removal of inedible or rough undesirable parts of food materials, usually outer parts. This unit operation helps improve quality of raw materials and products. This can be achieved manually. However, with the aid of equipment like pressure vessels or steam peeling, mechanical/rotating blades, abrasive rollers/bowls, and flame furnaces, peeling of raw materials can be done faster (Table 1).

Type of Food	Type of Force Required
Soft Foods	Impact and Shear (Attrition)
Brittle or Crystalline Foods	Compression
Fibrous Foods	Shear (Attrition)

Table 1: Types of Force Requirement for Different Types of Foods [20].

Mechanical Processing Stages: There are number of unit operations that requires mechanical processing. This may be determined by the process, volume, required speed and the nature of the final product. Where it is not a domestic or small scale processing, equipment/machine will definitely be needed. In some cases, the following unit operations may applies.

Size Reduction: This is the operation where solid materials are reduced into desired particle sizes, mostly by mechanical means. The mechanical process may involve one or more of these: compression, shear (or attrition), or impact force. The structure of a food material directly affect its hardness and determines the amount of energy required to fracture it. The force required to fracture certain type of foods is as shown in the table below: A number of designed equipment like jaw crusher, roll crusher, attrition mill and impact mills are used to reduce sizes in food industry.

Size Enlargement: As it is possible to reduce the sizes of material, it is also possible to increase their sizes as well. This unit operation, called size enlargement, helps to increase the particle size of food (Solid) material through mechanical processes, such as extrusion (non-thermal extruders, single-screw extruders, twin-screw extruders and refrigerated extruders), agglomeration (through the aid of rotating pans, rotating drums, high-speed agitators, tableting equipment and pelletizing equipment) and forming (bread molders, pie and biscuit formers, and confectionary molders).

Homogenization: helps to reduce the particle size of liquid (semi solid and Liquid) food. It also helps to increase the consistency. This is achieved by equipment such as homogenizers, emulsifiers, colloid mills, high shear mixers.

Mixing: is the incorporation of two or more components to form homogenous mixture. The mixing operation may be liquid-liquid mixture, liquid-gas mixing, solid-liquid mixing, solid-solid mixing and gas-gas mixing. The method of mixing equipment depends on the degree of mixing required. Such equipment include fluid mixers, agitated tanks, paddle mixers, anchor mixers, turbine mixers, dough/paste mixers, horizontal dough mixers, sigma-blade mixers, cutter mixers.

Heat Processing Operation: In the production of some food products, heat application is inevitable. In this process, heat transfer equipment are needed. The heat process may be needed to process, preserve or package the food product. Although, it was reported that heat may affect some nutritional composition, textural characteristics, functional properties, sensory attributes and flavor of food [20,24] still, heat application is indispensable in food processing. Some unit operations where heat process is employed are:

Baking: involves heat transfer to food mostly by conduction and convection and sometimes by radiation. Baking may cause physical and chemical changes in food product (bread and biscuit). Baking process requires the use of ovens whose designs may vary. The baking operations may be batch, semi continuous, or continuous.

Blanching: is a form of mild heat application, with temperatures of 88 – 99°C [20] for a short period. The main aim is to destroy or inactivate enzymes, sustain natural color and flavor of fruits and vegetables. Blanching may be useful in cleaning, removal of excess air, and softening the tissue to facilitate packaging. There are steam and hot-water blanchers used for this operation.

Drying: is a common unit operation in food process. It is usually employed with an intention to remove water from solid, semi-solid, or liquid food materials, resulting in products with low water/moisture contents. This is achieved with the aid of dryers (convective dryers, contact (conductive) dryers, vacuum dryers, freeze dryers, drum dryer, spray dryers, tunnel dryers, flash dryers.

Evaporation: is a heat process where the concentration of a solution is increased by removing considerable amount of moisture from the solution. Apart from helping in increasing shelf life, this operation reduce weight and volume of the solution, thereby aiding large transfer and distribution of the product. This unit operation in many cases is pre-unit (preliminary) operation for some other unit operations like drying, crystallization, precipitation, and coagulation. Evaporators are equipment used for evaporation process and can be classified based on operation and circulation.

Sterilization: helps to process food material under high temperatures usually above 100 °C to inactivate all microorganisms and enzymes. This may be achieved by steam, hot water or direct flames. It is relevant in preservation process, even though excessive heat application may result in loss of quality of the food materials.

The contribution of engineering is well evident in many emerging food technologies [24]. According [25] the fact that a lot of people depend on processed food created millions of job opportunities in various food industries. The application of emerging technologies purely aided by science and engineering principles is on the increase [24,25]. Some of the emerging technologies [25] are: High frequency pulsed electric field, High hydrostatic pressure, Ohmic heating, Microwave heating, Ultrasonic processes, Infrared heating, UV disinfection, Nanotechnology, and Cool Plasma.

Business Model Innovation for the Resilience of Food Systems

Business model innovation generally refers to the search by companies for new business logics and new ways to create and capture value for their customers, partners, and suppliers [26]. It offers the potential to provoke sustainable changes through the development and mobilization of organizational and managerial dynamic capabilities [27].

A transition concept – which refers to a gradual and reflexive trajectory of change from one state of production, processing, and consumption to another [28] – brings into focus the new state to be achieved, the path towards a new state, the transition problems including path dependencies and lock-in effects in the system to be changed, and the wide range of internal and external developments that may shape the outcome [29].

The growing body of literature on sustainability transition concerns the long-term transformation towards sustainability of sociotechnical systems in various domains, such as energy and water supply, transportation, and agricultural and food systems [30].

Agri-food systems transition management is a program, model, and set of tools or instruments to support the co-evolution of three types of sociotechnical systems landscapes, regimes, and niches. A sociotechnical system is a collection of stakeholders, their networks, practices, and knowledge; the technologies they use; their collective representations; and the standards and rules they adopt [28].

The landscape encompasses the trends and global pressures, such as the growing population, food security, public food policies, ecosystem degradation, resources depletion, and health problems related to food within which action will be taken [1].

The sociotechnical regime comprises the network of dominant actors, formal and informal rules, technologies, and consumption behaviour that form and maintain the globalised agro-industrial food system [30].

The landscape constitutes a source of pressure for regime change and opportunities for niche development [31]. Societal change come about through 'transition pathways' [5] formed through interaction, alignment, or co-evolution of objectives and practices between all relevant actors at different societal levels, such as the food policies and institutions, universities, agri-food industries, supply chain participants, and consumers.

The complexity of a food system transition – due to the fixed infrastructure and rigid policies at the landscape level, the various actors governing the dominant agro-industrial regime, and the multilevel processes involved in the change program – underscores the necessity of studying specific programs that have deployed SDGs to accelerate transition in the food systems, that is interactions within and between the three sociotechnical systems, landscape, regime and niches.

Conclusion

The goal of engineering of food is to enhance the welfare, health and safety, with the minimal use of natural resources and paying attention with regard to the environment and the sustainability of resources. Food engineering, as a component of the global food system, bears a special duty to society. Food is undeniably important to every single person on the earth. It has always! Unlike other manufacturing companies that arose following the industrial revolution, the food industry has always been focused on meeting a basic human need. There is substantial evidence and widespread consensus that a lack of key micronutrients such as zinc and vitamin A affects hundreds of millions more people. Sustainable engineering is the art of using various management tools and methods to design, practice, and continuously improve a product to achieve sustainability. This contribution can only be effective and fruitful if the different activities carried out in eco innovation projects are constantly interrelated and if the local decisions are taken by participants through a systemic view of the project's performance. This paper is meant to increase the understanding of engineers and teachers about how to practice and teach engineers and young managers about sustainable development practices and policies. This contribution can also encourage established firms and recently graduated food engineers to use their skills and knowledge to help address the growing economic, environmental, and social challenges in agricultural and food systems. To conclude, I expect that these contributions can inspire and encourage the development and application of food engineering-based solutions to build sustainable and resilient food systems, and increase food and nutrition security.

Author Contributions

Author have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

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Conflict of Interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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