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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 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.

KEYWORDS
Food engineering, food systems, resiliency, nutrition security, business model innovation for food systems, sustainability

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[1,2]. 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.

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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 how institutions, agriculture and farmers, food companies and consumers organize their activities for producing, preparing and consuming food items[3]. These concerns range from socioeconomic issues such as rural poverty and small farmers' vulnerability to environmental issues such as air pollution, species diversity, ecosystem integrity, increased food miles and intensive livestock production, as well as nutritional and health issues associated with improper food consumption and poor diets.

Today, the repercussions of these concerns and solutions are front and center on the political agenda, reform programmers and future goals and scenarios[4-6]. They propose an 'ecological transition' through innovation that develops and disseminates clean technology while also initiating larger changes in sociotechnical systems[7]. 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[8]. 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.

Despite increased research on a wide range of issues concerning sustainable engineering[9], more study is required to supplement the 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 integration 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 literature on Food engineering; Food systems; Resiliency; Nutrition security; Business model innovation for food systems and Sustainability. The following databases were 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[10] and the PICOS (population, intervention, comparator, outcome and study design) aspects in current search approach. The English-language publications published between January 1983 and December 2022 were considered. Similarly, the reference lists of the retrieved papers for further relevant material were 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 knowledgeable about 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 that produce food materials or products. As a result, a food engineer is a science generalist rather than an expert in one area. Because foods are composed of a wide range of physically and chemically complex ingredients, they must be researched 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 private consultants[11,12].

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. A greater emphasis on science and engineering is required to meet the demands of a world where many nations are unable to produce enough food due to the logistical and technical difficulties involved in feeding the population. The advancement of computational techniques as instruments for process automation, control, design and improvement will be spearheaded by upcoming food engineers[11,12]. High hydrostatic pressure, pulsed electric fields, light pulses, oscillating magnetic fields and ultrasound are examples of novel technologies that have the potential to affect 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[11,13]. The need for more affordable food production techniques has driven the development of several production cost-cutting techniques over the past 50 years, including Kaizan, lean manufacturing, Six Sigma and others. While effective instruments for raising production levels, they focus mostly on small steps at a time and do not acknowledge the necessity of drastic adjustments or the creative skill set that a food process engineer views as their main responsibility.

Formerly, the main factors influencing food growth and profitability were taste, cost and convenience; however, today's rising factors also include experience, safety, social effect and health and wellness, with transparency emerging as the most important factor overall[14].

Modern food and beverage manufacturing processes encompass all unit operations, mass and transport phenomena across all materials due to their extreme sophistication. Chemical process engineering is growing in popularity in the food industry since the same could be stated about it. It should be emphasized, therefore, that food engineering's natural home is found in its agricultural roots and raw material supply, not in the discipline of chemical engineering.

The system and structures of food, production procedures and physical, (bio)chemical and biological transformation processes are all covered by the technical, multidisciplinary field of food engineering[15]. It is based on economic, ecological, social, cultural and religious principles in addition to scientific laws.

In order to create a more connected, sustainable and secure food supply chain, the COVID-19 pandemic has taught people all around the world how to construct an integrated approach that involves food science professionals, land-based agriculture and food engineering disciplines. All food stakeholders must unite behind a single voice to urge the government to support large-scale funding possibilities for upcoming food research and the capacity to create innovative food production systems that will enable the delivery of the same at scale.

According to core competencies, 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. The following important areas were prioritized according to results from a 2016 worldwide web survey of the food engineering profession that addressed impending difficulties in the food business[11,16]: (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 (SDGs). The SDGs 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[5].

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[13].

Today countries around the globe face significant global problems in terms of food and nutrition security. By 2050, it is estimated that food systems will have to provide around 10 billion people globally with food that is safe, inexpensive, nutritious and compliant with social and ethical standards. In addition, we have to do it in a sustainable way, which means minimizing and making the best use of resources like food, energy, water and land. Food systems play a major role in many of the sustainability goals set forth by the UN.

The current food systems are weakly robust and highly integrated/globalized, making them susceptible to local and global pressures such as natural disasters and political, economic and social upheavals. It is anticipated that stresses to food systems, such as pandemics, economic shocks and the effects of local and global climate change, will persist in the (near) future. Building resilient food systems is therefore essential to preventing future disruptions and lowering the poverty of food and nutrition. It is evident that these complicated and dynamic problems cannot be solved easily and that a multidisciplinary team effort is required.

Some general solutions for food systems include creating more sustainable processes that use less water and energy and generate little to no waste. Valorization of byproducts, byproduct streams and "waste" food should have a longer shelf life. Food nutritional profile enhancement; reduce the usage of highly processed and dry ingredients in favour of more functional and sustainable options[11,13]. 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:** It 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:** It 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:** It include supply chain sustainability assessments, system engineering studies and the management of concentrated, less refined and stable substances

A broad range of solutions are contributed to this collection, including illustrations of pertinent strategies for achieving the specified objectives.

A comprehensive overview of the advancements and future prospects of novel processing technologies for improving plant protein quality and characteristics[17]. Although there are several disadvantages, such as lengthy and energy-intensive processes, large water consumption and losses of essential compounds in the final product, traditional thermal (intense) processing is generally utilized. Rather, a number of emerging technologies have been investigated, such as cold plasma, ohmic heating, high pressure, pulsed electric field, supercritical fluids, microwave and enzymatic processes.

To increase process efficiency, these technologies can be utilised separately or in combination. Emerging technologies offer a promising mix of processing practicality with minimal environmental impact and increased nutritional properties and protein technological functionalities. They are non-thermal or operate at low temperatures for brief periods of time. The authors stress the potential of these new methods to produce plant-based proteins of sufficient quality, but they also warn that further research is necessary, especially in the areas of plant protein digestibility and amino acid composition. Ultimately, it is found that greater development at bigger proportions than those achieved in the laboratory is needed for the practicality of industrial use.

Cassani and Gomez-Zavaglia[18], discuss the state of affairs today and the potential for fruit and vegetable wastes (characterization, availability) as sources of valuable ingredients (fiber, polyphenols, pigments) that can be added to food, pharmaceutical and cosmetic products. When it comes to food waste and losses, fruits and vegetables rank highest, losing between 40 and 50 percent of their production. This present issue presents a huge potential to create strategic resilience plans for the recovery of important compounds within the framework of a circular economy. Specifically, fruit and vegetable peels, pulps, pomaces and seed fractions might serve as appropriate starting points for the extraction of several bioactive substances, such as pigments, polyphenols and fibre (pectin and prebiotic oligosaccharides). Depending on the specific component, the authors also address practical and sustainable extraction/obtention procedures for waste valorization. They draw attention to the necessity of transferring laboratory-scale research to industrial operations to fully use these reasonably priced basic materials. However, it is also asserted that the value-adding of fruit and vegetable by-products will support environmentally sound practices and the development of vibrant, competitive regional economies, particularly in developing nations and rural areas. Lastly, the authors examine the advantages of applying a circular economy approach to supply chain development, particularly for businesses, taking into account a broad definition of sustainability that encompasses social, financial and environmental factors.

The current study examines how the flavour, microstructure and myofibrillar proteins of the giant yellow croaker-a significant marine cultured fish that is extensively disseminated throughout China-are affected by ultrasound-assisted freezing[19]. It is commonly recognised that freezing effectively increases the shelf life of food by preventing microbial development and reducing biochemical reactions; nevertheless, the freezing technique (i.e., freezing rate) used will determine the quality of frozen fish consequently, a number of cutting-edge and novel freezing methods have been put forth as a potential remedy to maximise the crystallization of frozen fish. The authors of this study assessed air freezing, 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) as the five different freezing treatments. The results showed that a large yellow croaker's flavour qualities and myofibrillar protein features may be effectively enhanced by multi-frequency ultrasonic treatment (TUIF). The scientists concluded that freezing food with multi-frequency ultrasonic assistance can be a successful and sustainable means of enhancing food quality and nutritional profile.

A sustainable film that combines polylactic acid (PLA) and N-halamine compound (MC) has developed to serve as a potentially effective antibacterial food packaging material for fresh produce[20]. A class of substances known as N-halamines is made up of one or more nitrogen-halogen covalent bonds. These chemicals have the ability to effectively inactivate microorganisms due to the strong oxidative state that the high-energy halide bond affords. In addition to having mechanical qualities similar to those of polystyrene (PS) and polyethylene terephthalate (PET), polylactic acids (PLA) are also compostable.

In order to create an antimicrobial food packaging film with appropriate mechanical strength and transparency, the authors consequently grafted MC onto PLA resins. High transparency, robust mechanical strength, thermal stability, water vapor barrier and oxygen permeability were all displayed by the produced PLA-MC films. Seven logs (full inactivation) of *S. aureus* and *E. coli* were inactivated by PLA films containing 0.25% MC in 30 and 5 min of contact, respectively. Strawberries wrapped in films containing MC had a minimum of five days of shelf life at room temperature in pilot testing. The scientists concluded that these films have a wide variety of potential uses in the field of food packaging to enhance the shelf life of fresh produce because of their ease of manufacturing and efficient biocide properties.

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[2,21,22]. There is a strong connection between effective food systems and food safety. Effective engineering applications in various stages and operation of food systems 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[23]. Processing of food products often begins with sourcing 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[22]. Food raw materials can be classified into four major categories: The unprocessed agricultural produce, semi-processed agricultural products, finished products and by-products.

Unprocessed agricultural produce: They are in natural unprocessed form as harvested from farms (tubers, fruits and vegetables, grains and cereals, raw meat and 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 the sourcing exercise should aim at obtaining the best quality of raw materials at the 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 for 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 is production of raw food materials to edible products. The sensory and texture qualities, nutritional composition and health benefits are expected to be intact. Production of food may involve several unit operations[22]. The application of engineering principles in various unit operations is 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 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 a sequence of unit operations[22]. Industrial food production requires an organized manufacturing environment, where a needed combination of applicable unit operations is strategically positioned. This is achieved by a 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[24].

Plant layout is the strategic arrangement of structures, machines, facilities and offices on the industrial site, this aids effective, smooth flow and safe operation. The effective arrangement creates unhindered accessibility of the personnel and 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, the flexibility of operation and proper supervision of staff and activities is encouraged[24,25]. A thorough analysis of facility infrastructure, process, materials, equipment, personnel storage, logistics and other related processes is 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[22]. 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[11,13,22].

Cleaning: Depending on the raw material and the source, there may be a 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: The sorting process can be manual or with the aid of machines. This operation is useful in separating food materials based on specified parameters and sometimes may function as a cleaning operation (removal of foreign matters and contaminants). Sorting separates food materials based on 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 operations.

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

Peeling: The removal of inedible or rough undesirable parts of food materials, usually outer parts. This unit operation helps improve the 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, the peeling of raw materials can be done faster.

Mechanical processing stages: There are a number of unit operations that require 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/machines will be needed. In some cases, the following unit operations may apply.

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 affects its hardness and determines the amount of energy required to fracture it. The force required to fracture certain types of foods is as shown in the table. A number of designed equipment like jaw crushers, roll crushers, attrition mills and impact mills are used to reduce sizes in the food industry.

Size enlargement: Material sizes can be reduced, but they can also be increased. This unit operation, known as size enlargement, aids in increasing 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 (with the aid of rotating pans, rotating drums, high-speed agitators, tableting equipment and pelletizing equipment) and forming. Table 1 shows the types of force requirements for different types of foods[22].

Homogenization: It 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.

Table 1: Types of force requirement for different types of foods

Type of food	Type of force required
Soft foods	Impact and shear (Attrition)
Brittle or crystalline foods	Compression
Fibrous foods	Shear (Attrition)

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

Heat processing operation: In the production of some food products, heat application is inevitable. In this process, heat transfer equipment is needed. The heating 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 still, heat application is indispensable in food processing[22,23]. Some unit operations where heat process is employed are.

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

Blanching: Blanching is a form of mild heat application, with temperatures of 88-99°C for a short period[22]. The main aim is to destroy or inactivate enzymes and sustain the natural color and flavor of fruits and vegetables. Blanching may be useful in cleaning, removing excess air and softening the tissue to facilitate packaging. There are steam and hot-water blanchers used for this operation.

Drying: Drying is a common unit operation in a food process. It is usually employed 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 dryers, spray dryers, tunnel dryers and flash dryers).

Evaporation: Evaporation is a heat process where the concentration of a solution is increased by removing a considerable amount of moisture from the solution. Apart from helping in increasing shelf life, this operation reduces the weight and volume of the solution, thereby aiding large transfer and distribution of the product. This unit operation in many cases is a pre-unit (preliminary) operation for some other unit operations like drying, crystallization, precipitation and coagulation. Evaporators are equipment used for the 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 the 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[26]. According to Cheruvu *et al.*[27], 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[26,27]. Some of the emerging technologies 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: According to Aspara *et al.*[28], business model innovation is the term used to describe an organization's search for new business logic and methods to generate and capture value for its partners, suppliers and customers. Through the growth and mobilization of organisational and management dynamic capacities, it has the ability to bring about long-lasting improvements[29].

The term "transition concept" refers to a gradual and reflective trajectory of change from one state of production, processing and consumption to another[30]. This concept focuses on the path towards achieving a new state, the transition problems that arise from changing the system, such as path dependencies and lock-in effects and the multitude of internal and external developments that could influence the final result[31].

The expanding corpus of research on sustainable transition focuses on the long-term conversion of sociotechnical systems in a number of fields, including transportation, agriculture and food systems, energy and water supply and agriculture[32].

A programme, concept and collection of instruments known as "agri-food systems transition management" are designed to facilitate the co-evolution of three different kinds of sociotechnical systems landscapes, regimes and niches. It is a sociotechnical system consists of a group of stakeholders, their networks, activities and knowledge; the technologies they employ; their shared representations; and the norms and regulations they embrace[30].

The environment in which action will be implemented includes global trends and pressures such as population growth, food security, public food policies, ecological degradation, resource depletion and food-related health issues[3].

The globalized agro-industrial food system is formed and maintained by the network of dominating actors, official and informal regulations, technology and consumption patterns that make up the socio-technical regime[32].

According to Smith *et al.*[33], the environment creates both chances for niche development and pressure for regime change. Transition pathways are the means by which societal change is brought about[7]. These pathways are formed through the interaction, alignment, or co-evolution of objectives and practices between all relevant actors at different societal levels, including consumers, agri-food industries, universities, food policies and institutions and supply chain participants.

The numerous players controlling the dominant agro-industrial regime, the rigid policies and fixed infrastructure at the landscape level and the multilevel processes involved in the change program all contribute to the complexity of a food system transition. This highlights the need to examine specific programs that have implemented SDGs to speed up the food system transition, i.e., interactions within and between the three sociotechnical systems, landscape, regime and niches.

CONCLUSION

The goal of food engineering is to enhance 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 been! 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 discipline of applying multiple management tools and approaches to develop, implement and continuously improve a product in order to attain sustainability. This contribution will only be effective and fruitful if the many activities carried out in eco-innovation projects are constantly interconnected and local decisions are made by participants based on a systemic perspective of the project's performance. This study aims to improve engineers' and instructors' awareness of how to use sustainable development methods and policies, as well as to teach engineers and young managers about them. This contribution may also motivate established businesses and freshly graduated food engineers to apply their skills and knowledge to address the growing economic, environmental and social concerns in agriculture 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.

SIGNIFICANCE STATEMENT

In response to supermarkets gaining more power, manufacturers businesses are forming global strategic alliances with other significant companies. This enables them to profit from cooperative marketing or research and development while concentrating on their core products and generating pan-regional economies of scale. The article seeks to familiarize food manufacturers, researchers in the area and students of food engineering and technology or chemical engineering, the wide range processing techniques utilized in food processing and application of engineering of food to build resilient food systems. At the same time, the United Nations Sustainable Development Goals (SDGs) can help organizations discover and pursue opportunities for business model innovation.

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