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Agro-food systems and environment: Sustaining the unsustainable

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Abstract

Ecological footprints have made it possible to study the dependence on natural resources and the human impact derived from the substantial growth of the world population. Food security represents the sufficient and stable availability of food, with timely and stable access for future generations. Food security is an essential issue for agri-food systems that have been greatly affected by the demand for food, the current problems of sustainability, the high losses of food and waste generated in the production and supply chain, the limitations of natural resources and climate change. The circular economy still being a model of production and consumption under the reuse and recycling of materials for as long as possible to face the challenges of climate change, resource depletion and population growth. Currently, there is a need to adopt a political strategy of gradual transition and full integration of the different world entities from the different political sectors to achieve a sustainable and balanced food system with environmental, economic, and social sustainability. This review highlights the need to change the unsustainability of various in-practice agri-food systems and their interactions with the environment. Further, considering the Sustainable Development Goals of United Nations, insightful perspectives have been given to preserve and enhance sustain the agro-food systems and reduce the environmental impact for global sustainable food security.

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Sustainable agro-foods systems, Food security, Nutritional value, Food quality, Sustainability, Sustainable Development goals.

Introduction

The current transformation of our planet derived from the exponential growth of the population and its consequent demand for food, resources, and the emission of greenhouse effect gas, had never been experienced. The Paris Agreement recognized the importance of safeguarding food security, ending world hunger, and generating a sustainable food production system to mitigate environmental impacts [1]. The agri-food system is at the center of global environmental, economic, and social challenges, climate change, the scarcity of resources, the degradation of ecosystems, and biodiversity loss. The way in which food is produced, distributed, consumed, and food waste management is closely related to hunger, malnutrition, poverty, water scarcity, land degradation, and climate change. Currently, food systems produce enough food for the entire world population. Still, food insecurity problems derived from differences between countries persist, revealing an extreme need for a transition towards more sustainable food systems to provide food and nutritional security and environmental sustainability [2–4].

The current food system has demonstrated an urgent need for a transition towards sustainability with food insecurity, malnutrition, and obesity that affect more than half of the world's population through the consumption of food with contaminants, such as endocrine disruptors that cause significant adverse effects on the health [3*]. In September 2021, around 161 million people in 42 countries or territories were estimated to be in food crisis or worse, level 3, of the Integrated Food Security Phase Classification (IPC). In countries such as Yemen, Ethiopia, Sudan, and Madagascar an increase in people facing famine/disaster (IPC level 5, highest level) with a total of 584,000 people facing food-

deprived households where action is required urgent to prevent hunger, death, and collapse of livelihoods [5].

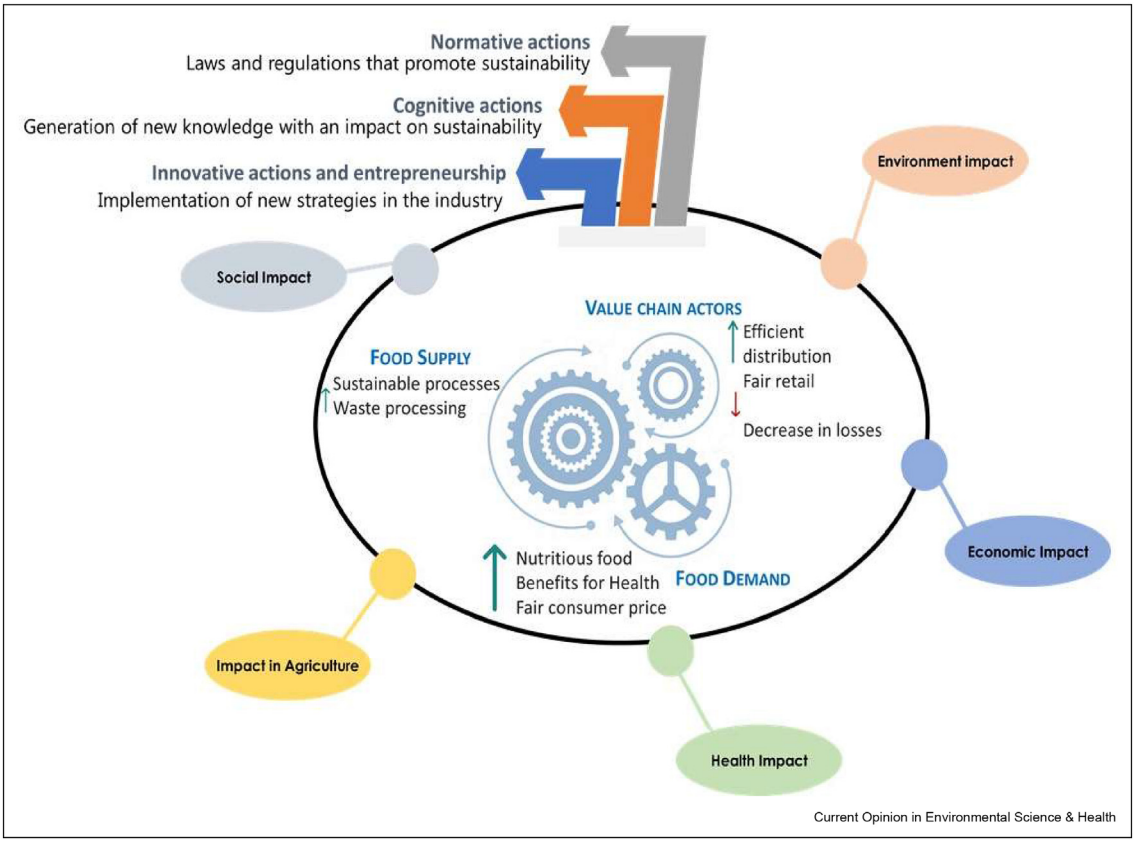
Currently, only 8.6% of the world economy is defined as circular, and it is necessary to move towards a circular, regenerative, and sustainable bioeconomy, for the sustainable production and reuse of natural resources, considering the various factors in the medium and long-term, which may impact the environment and society [6]. The progress and transition toward sustainable food systems is a complex task that requires political efforts that are strictly coordinated and integrated to achieve a sustainable agri-food system, with a balance between the demand for natural resources, the environment, economic, social and health impacts (Figure 1).

This article provides a deeper understanding of the need to implement sustainable agrifood systems worldwide to produce food and natural resources necessary for human subsistence and that interact in a balanced way with the environment, society, and socio-economic policies, seeking to reduce the negative impacts generated in recent decades. Compared with literature reviews in the field we emphasized the concepts of circular economy, and how science and research will evolve to construct new food systems for the sustainability based on the regeneration of policies through environmental improvement.

Research on agro-nutrition and food sustainability

One of the most critical outcomes of sustainable agro-food systems is food and nutrition security. Half of the global population is affected by food insecurity and malnutrition [7], an indicator of the dysfunctions of the existing food system. Campbell [8] reported that the food system is the major user and polluter of water and land. However, the agri-food sector is one of the main drivers that can influence reducing poverty and vulnerability [9,10]. Thus, this asserts the interest in increasing sustainability, and green investments in the agri-food sector [10,11]. Moreover, three perspectives have been explored to reduce the lack of sustainability in agro-food systems and reduce food insecurity: 1) The increase of efficiency by changes in production, 2) Demand restraint by changes in consumption, 3) Food system transformation by changes in food system functioning and governance [2]. Nevertheless, it has been widely recognized that agri-food systems are failing to ensure an affordable source of raw materials for food

Figure 1



Summary of actions and impacts on agri-food systems towards sustainability. Created with BioRender.com and extracted under premium membership.

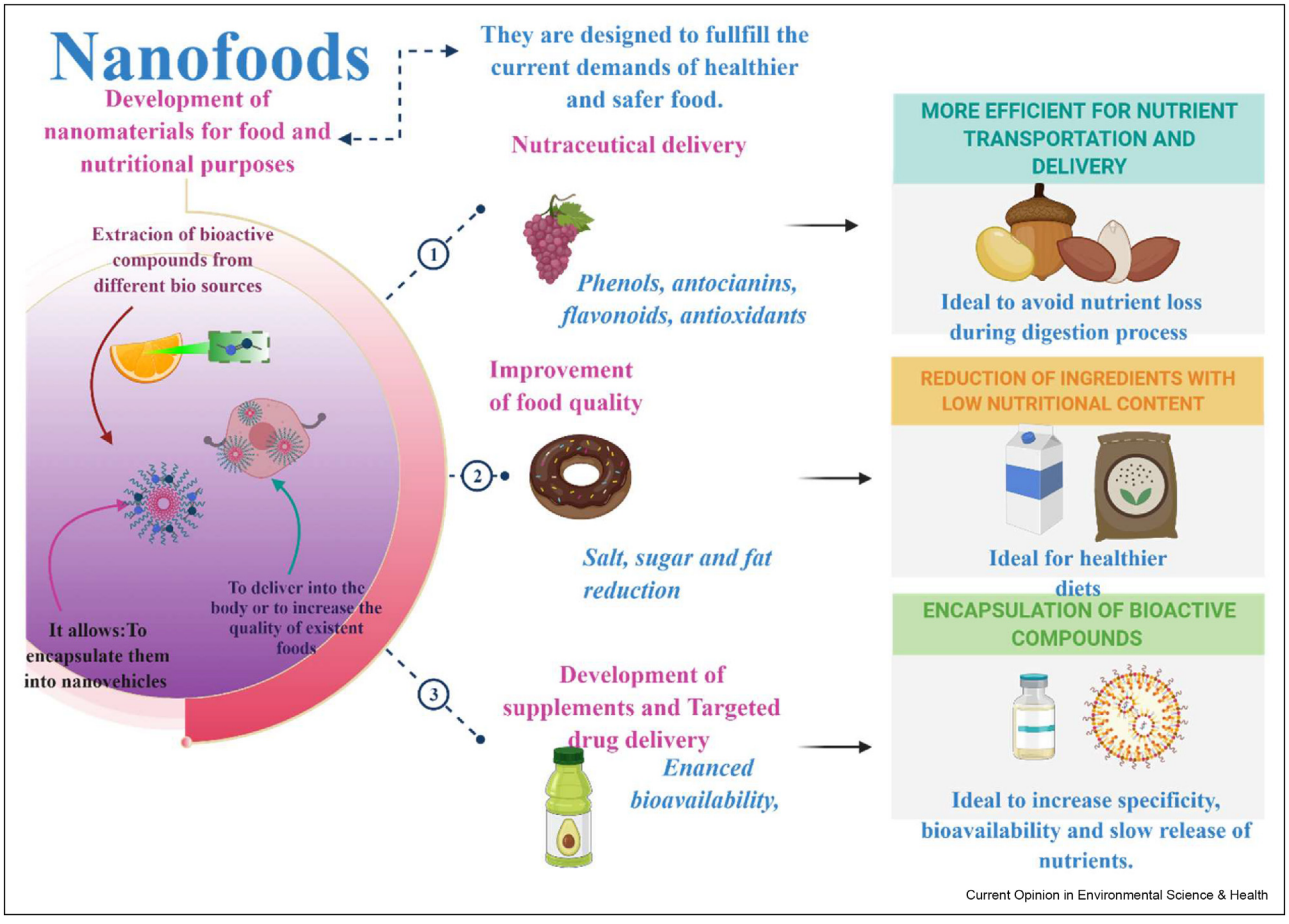
production and, simultaneously, to guarantee the production of nutritious food [12**].

The sustainability of the agri-food system is one of the critical challenges of this century because it influences the basic needs for social development [13–15]. It is essential to integrate social issues, politics, and governance in the path toward the sustainability of agri-food systems [2,3*]]. Moreover, it has become a necessity to integrate the perspective of different areas of knowledge, such as social discipline, economy, political sciences, and technological areas (biotechnology, engineering, among others), to reflect better the complexity of food production and their implication in nutrition and social development [16]. This will help respond to the demands of the different stakeholders to transition from an unsustainable structure to a sustainable system that contributes to the development of society.

Sustainable agri-food systems: Environment, socio-economic prospects, and policy

Many food systems are unsustainable due to their unacceptable environmental impacts and are causing the depletion of non-renewable resources. Agri-food production is based on fossil fuels, and non-renewable mineral resources. Additionally, it utilizes excessive fields by growing plants and causes depletion of groundwater resources, thus need ecosystem restoration in an effective manner [17]. The Food and Agriculture Organization (FAO) defined "sustainable" in the context of food systems production as the management and conservation of natural resources and the orientation of technological and institutional change in such a manner to ensure the attainment and continued satisfaction of human needs for present and future generations. To overcome the challenges of the transition to a sustainable food system, a global, multidisciplinary, and focused effort on sustainable

Figure 2



Insight of nanotechnological processing for nano-fortified functional foods and nutraceutical. Reprinted from the study by Aguilar-Pérez et al. [25] with permission, Taylor & Francis License Number: 5416671102782.

production and consumption is needed that reflects the Sustainable Development Goals (SDGs) of United Nations [18*,19]. Goal 2 reflects food security and sustainable agriculture. Goal 12 shows relevance in sustainable consumption and production and, Goal 13 highlights the urgency to act for climate change [19].

Recently, with the spread of the COVID-19 disease issues corresponding to global agri-food production and consumption, food supply chains have manifested. To establish a circular agri-food system, different contributions of Sustainable Oriented-Innovations (SOIs) have reduced the adverse effects of the governance of the agri-food value chains. SOIs tackle challenges such as food waste, CO_2 emissions, land degradation and reuse of materials [20]. The comprehensive analysis of the agri-food and their relationship with sustainability provides inputs in environmental, economic, social, and political dimensions. For the environment, the agriculture of food systems should take place within planetary boundaries and safe space for human beings. Water, land, nutrients, and energy should be used in a central way and more particular attention may be paid to the circular economy in determining sustainability. Organic farming and agro-ecology offer promise for the agri-food products in the future. Many small producers are practicing these schemes with high-value benefits to the environment [12]. Additional recommendation is to change to a more sustainable plant-diet, such as a vegetarian diet, to reduce the environmental impact [21].

In the economical field, the sustainability of agri-food is addressed by the adoption of markets for food access and supplies, including the commodification of products [22]. The impact of the level of prices for agri-food products and their volatility induces people to eliminate their diet and consume food with high levels of sugar or carbohydrates, leading to adverse health effects [23]. Price should not be an inconvenience for food accessibility and should be fair for producers. Social concerns of the agri-food systems based on human rights need transformation to food security, decent livelihoods, gender equality and safe working conditions among others to achieve sustainability. Social and cultural roles of people are crucial to adopt alternative foods; for example, emergent sources of proteins for food [24]. In the context of policy, and its transition to more sustainable schemes. Local, regional, and national approaches should be addressed. Studies in urban food have focused on developed countries and several documents have been known, showing strategies, guidelines, and action plans with particular attention to SDGs [12].

Conclusions and future recommendations

Our current food systems are unsustainable, many challenges are coming with the world population growing and the depletion of the capacitance of the planet. In addition, climate change increases the risk of global food production. Moreover, three perspectives have been explored to reduce the lack of sustainability in agro-food systems and reduce food insecurity: 1) The Increase of Efficiency by changes in production, 2) Demand restraint by changes in consumption, 3) Food system transformation by changes in food system functioning and governance. Also, food systems meet the environment's needs, society, economy, and politics. We need to improve the management of natural resources, promote less use of chemicals in the soil, and adopt the valorization of waste to produce high-value products through circular economy strategies. The rescue of biodiversity, avoiding the forest damage. Governments delivered urgent approaches to diversify the opportunities for small farmer producers, obtain fair prices for their products and increase marketing opportunities. For social issues, the empowerment of women and gender equality is very important in the cultural transition in many countries. Also, the inclusiveness in global, and local food chains. Research in agri-food systems has integrated the knowledge of prospects for sustainable nutrition, and transition towards sustainable food systems. For future perspectives, insight into nanotechnological processing for nano-fortified functional foods and nutraceuticals must be prioritized to sustain the unsustainability of food scarcity. In the 21st-century food sector and as per the SDGs, nano-tech based food processing is a new frontier that has a vibrant effect on enhancing the overall food quality, nutritional value, food safety, and nano-fortified functional foods aspects (Figure 2) [25**].

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this article.

Data availability

No data were used for the research described in the article.

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