

Building a more sustainable food system in Colombia: a role for nutrition professionals

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Abstract

This article describes multiple efforts to facilitate the transition to a more sustainable food system in Colombia, which can contribute to the achievement of climate-, biodiversity-, and health-related goals. These interconnected goals are aligned with Colombia's plan for sustainable development and food sovereignty, guided by a food systems typology developed by the World Wildlife Fund, Colombia, and through support of the concept known as *Buen Vivir*. Public health nutrition professionals can increase food security, build food sovereignty, and facilitate the transition to a more sustainable food system in Colombia through: (1) community food gardening and peri-urban and urban agriculture projects; (2) institutional- and consumer-level food waste reduction and prevention programs; and (3) sustainable menu projects that incorporate indigenous, native, and local foods that facilitate the recovery of food memory. Such projects should be participatory and tailored to meet the needs of stakeholders in the different regions of Colombia.

Keywords: *sustainable food systems, Colombia, climate change, biodiversity, food sovereignty, Buen Vivir, agroecology, agroforestry, sustainable diets, food waste*

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1. Introduction

A sustainable food system is a food system that delivers food security and nutrition for all [1]. A sustainable food system is a key factor in achieving the United Nations' Sustainable Development Goals (SDGs). "Adopted in 2015, the SDGs call for major transformations in agriculture and food systems in order to end hunger, achieve food security, and improve nutrition by 2030. To realize the SDGs, the global food system needs to be reshaped to be more productive, more inclusive of poor and marginalized populations, environmentally sustainable and resilient, and able to deliver healthy and nutritious diets to all. These are complex and systemic challenges that require the combination of interconnected actions at the local, national, regional and global levels" [2] (p. 1). See **Figure 1** for FAO's conceptual framework on sustainable food systems, which includes economic, social, and environmental impacts.

Bene et al. [3] found significant correlations between four global drivers and the unsustainability of food systems including an increase in population growth, agricultural land use (including large-scale acquisitions referred to as "land grabs"), female employment, and urbanization. Agricultural expansion is often linked to deforestation; this land conversion takes place largely in the Global South and is associated with large-scale land acquisitions or "land grabbing" [3]. In May 2024, the *IPES/Food International Panel of Experts on Sustainable Food Systems*

published a report on large-scale land acquisitions [4]. The purpose of this report was to document what is driving the unprecedented pressures on farmland. The report found that land concentration is exceptionally high in countries in Latin America, with 80% of all farmlands in Colombia being controlled by 1% of the population [4]. Land inequality is a well-documented phenomenon in Colombia [5, 6], with Indigenous Peoples and Afro-Colombians disproportionately affected [6]. The Committee on World Food Security Tenure Guidelines acknowledge that land tenure for Indigenous Peoples is essential for eradicating hunger (UN SDG #2—Zero Hunger) and meeting global climate goals (UN SDG #13—Climate Action) [7, 8]. Finally, the UN SDGs from an indigenous perspective in Colombia include food sovereignty and autonomy and support for an indigenous economy as key to meeting the following UN SDGs: SDG #2—Zero Hunger, SDG #8—Decent Work and Economic Growth, and SDG #12—Responsible Consumption and Production [9].

Wealth inequality is well documented in Colombia as well. "Between 2010 and 2022, Colombia's data on the degree of inequality in wealth distribution based on the Gini coefficient reached 51.5" [10] (p. 1). Based on these data, Colombia is ranked as the second most unequal country in Latin America [10]. "The Gini coefficient measures the deviation of the distribution of income (or consumption) among individuals or households in a

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given country from a perfectly equal distribution. A value of 0 represents absolute equality, whereas 100 would be the highest possible degree of inequality” [11] (p. 1). In 2023, the *UN Sustainable Development Goals (SDGs) Progress Report* articulated that “urgent coordinated action, and policy solutions are imperative to address entrenched inequalities, transform food systems, invest in sustainable agricultural practices, and reduce and mitigate the impact of conflict and the pandemic on global nutrition and food security” [12].

Food sovereignty is a vital component in Colombia’s current plan for sustainable development and sustainable food systems [13, 14]. Food sovereignty is defined as the peoples’ right to determine their food and agricultural systems. This includes the right to participate

in decision-making processes on food and agricultural policies and the right to access healthy and appropriate food produced through ecologically sound and sustainable methods that respect their cultures and the land [14]. The changes necessary to transform the food system of Colombia are complex and must include a diverse range of stakeholders. The purpose of this article is three-fold: (1) to describe numerous factors hindering the transformation to a more sustainable food system and building food sovereignty in Colombia; (2) to provide selected examples of positive food system transformation in Colombia; and (3) to describe how public health nutrition professionals can increase food security, build food sovereignty, and participate in a transition to a more sustainable food system in Colombia.

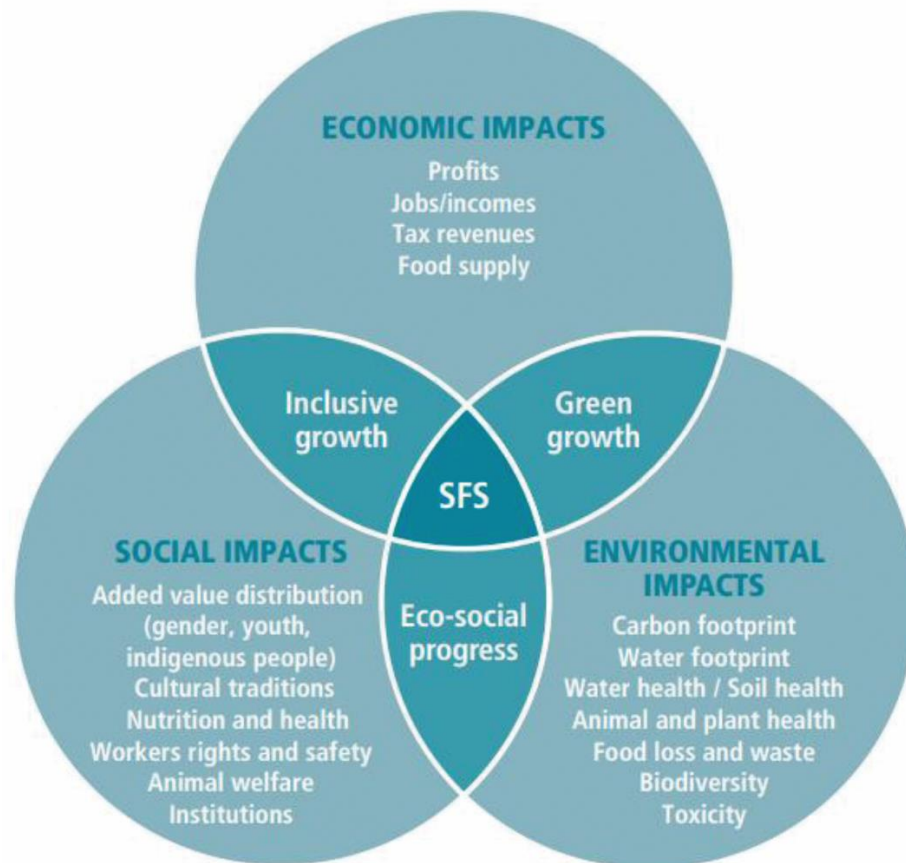


Figure 1 • Sustainable food systems: concept and framework [2]. SFS, sustainable food systems.

2. Colombian food system

Colombia is a medium-size upper-middle-income tropical country in South America with a population of 52 million people [15]. The country is organized into 32 decentralized departments and the Bogotá Capital District, the seat of the National Government. Colombia is also divided into six natural regions based on their ecosystems and climate: (1) Amazonian region, (2) Orinoquia region, (3) Andean region, (4) Pacific region, (5) Caribbean region, and (6) Islands (Archipelago of San Andres and Providencia in the Caribbean Sea, Malpelo and Gorgona in the Pacific) [16–18] (**Figure 2**). Given its designation as an ecological food system hotspot, an ecological food system hotspot is defined as a country that contains some of the richest and most threatened reservoirs of carbon, plant, and animal life on earth [18]. Colombia has an important role in meeting global climate and biodiversity goals [18]. Colombia is among the most biodiverse countries in the world [16, 18]. At the same time, there is a potential threat from

its large and expanding agricultural sector. Colombia exports commodities such as bananas, coffee, cattle, and flowers, and is the fourth largest producer of palm oil in the world [18]. In 2020, agricultural lands covered 43.5 million hectares of the land surface of Colombia (37.9%), the second largest area after natural forests. Most agricultural lands have been used as pasture for cattle raising, whereas a smaller share of agricultural lands have been used for permanent crops including coffee, palm oil, sugarcane, and annual crops such as rice, potatoes, cassava or yuca, and corn [19].

The World Wildlife Fund of Colombia has developed a food system typology “to address the complexity of conducting national food system analyses, and to better identify key-levers and facilitate the correlation between them, as well as to identify the trade-offs” [18] (p. 4). Colombia is a type 1 country (as is Brazil) based on the macro characteristics of its national food system [18] (**Table 1**). Colombia could benefit from strengthening its

national food system commitments, which will help Colombia deliver on its global climate, biodiversity, and health goals [16]. At the COP28 (28th Conference of the Parties to the United Nations Framework Convention on Climate Change) in Dubai, UAE, in December 2023, the President of Colombia, Gustavo Petro, stated [20] that “It is precisely because Colombia has a right to development that it should choose to diversify its economy and invest in food sovereignty [13, 14], agroecology [21], renewable energy sovereignty, and high value added industrial policies” [20].

“Agroecology is a holistic systems approach to producing food, which incorporates social, economic, and political dimensions. Agroecological practices include landscape and farm diversification, intercropping, crop and pasture rotation, adding organic amendments, cover crops, and minimizing or avoiding synthetic inputs. Social dimensions of agroecology include co-creation of knowledge with farmers, participatory processes, nonwage labor relations, collective property and management of resources, and addressing social inequities” [21] (p. 1).



Figure 2 • Political divisions (departments) and six natural regions of Colombia. Natural regions include Amazonian region (green), Orinoquia region (violet), Andean region (brown), Pacific region (blue), Caribbean region (white), and Insular region, Islands (orange)—San Andres and Providencia [17].

Table 1 • Overview of the characteristics of the Colombian food system^a

Variables	Type 1: Country ^b
Production System	Most of the land/waters are dominated by industrial food production with a smaller share farmed/fished by smallholders and artisans.
Self-Sufficiency	Sufficient land and water resources exist to produce enough food to meet domestic demand. Food may still be imported but that is not driven by land and resource constraints.
Food Security	Although enough food can be produced domestically, a large percentage of the population remain food insecure due to internal problems related to accessibility, availability, and affordability of food.
Consumption Patterns	Although a high level of food insecurity exists, the per capita impacts from food consumption are above planetary boundaries (i.e., ecological limits), mainly driven by high levels per capita intake of animal-source foods.
Biodiversity Hotspot	High levels of biodiversity richness are found in much of the country, with large areas considered biodiversity hotspots.
Irrecoverable Carbon	High levels of carbon reserves can be found in the country with large areas containing high density reserves of irrecoverable carbon.

^aA framework adapted from Wey and Gutierrez [18]. ^bBased on this typology, Colombia is designated as a type 1 country, which is based on the characteristics identified in this table.

2.1. Food production stage of the food system

During the food production stage, there are several obstacles that hinder the transformation of the Colombian food system including insufficient rural infrastructure, limited resource accessibility, market dynamics, the prevalence of monoculture agriculture (e.g., sugarcane, coffee, palm oil), overuse of land for livestock, and the cultivation of coca, which is linked to drug trafficking [18, 19, 22–25]. Land use, land-use change, forestry, and agriculture account for 59% of Colombia’s greenhouse gas (GHG) emissions [22]. Agriculture accounts for 21.6% of Colombia’s GHG emissions, with 14.8% of Colombia’s GHG emissions stemming from the livestock sector, mainly from enteric fermentation and manure management. The livestock sector occupies 91% of Colombia’s agricultural land. “The primary direct drivers of deforestation are expansion of the agricultural and livestock frontier, and to a lesser extent, illicit drug cultivation, mining and illegal logging” [22] (p. 20).

According to the World Bank, “the conversion of land to grazing and agricultural uses obscures the fact that land grabbing for speculative purposes is a major underlying driver of land-use change.” In fact, “Land grabbing is the primary factor behind deforestation in the Colombian Amazon, and accounted for 61% of the country’s total deforestation in 2021. It involves both state and non-state, legal as well as illegal, and formal as well as informal actors” [22] (p. 20).

Planting of illicit (illegal) crops, illicit cattle ranching, and deforestation are often intertwined problems. Rivadeneira et al. [23]

evaluated the impact of coca plantations on global- and local-scale deforestation in Colombia. At the national level, they found “a positive and statistically significant relationship between coca crops and deforestation. At the regional level, in two out of four regions, coca appeared to be causing deforestation, especially in the Department of Northern Santander and on the Pacific coast” [23] (p. 1). These authors observed that “narco-deforestation” is due to the quest to expand coca cultivation, launder illegal profits, and create clandestine routes and airplane strips, which can affect forests in nearby municipalities [23]. “Narco-deforestation” is defined by the UN as the laundering of drug trafficking profits into land speculation, the agricultural sector, cattle ranching (i.e., illicit cattle ranching or “narco-ranching”), and related infrastructure [24]. Crimes such as protection and extortion rackets, money laundering, and corruption have turned the border areas of the Amazon Basin into violent hotspots, with diverse organized criminal groups simultaneously engaged in cocaine production and trafficking and natural resource exploitation. Indigenous Peoples and other minority groups are disproportionately affected by the criminal nexus in the Amazon Basin [22, 24].

At the national level, livestock and agriculture are the most important drivers of deforestation [22]. Cattle ranching has taken over coca farming as the main driver of forest loss outside of the area where agricultural activities are allowed [19, 25]. In August 2023, leaders from countries that are part of the Amazon, including Bolivia, Brazil, Colombia, Ecuador, Guyana, Peru, Suriname, and Venezuela, met for the first time. At this multi-country Amazonian summit, representatives from each country pledged to redouble their efforts to protect the Amazon rainforest [26]. The Amazon Basin includes parts of Bolivia, Brazil, Colombia, Ecuador, Guyana, Peru, Suriname, Venezuela, and French Guiana, a territory of France. The Amazon Basin is important for planetary and human health because it contributes to stabilizing the local and global climate [27]. The natural resource base in the Amazon also contributes to the economic well-being of vulnerable groups including that of the Indigenous Peoples [22].

The World Bank has concluded that deforestation control in Colombia can be improved by (1) making law enforcement more effective, (2) bringing land grabbing in check, by focusing on the areas of the highest deforestation, (3) investing at scale in sustainable production and restoration in deforestation hotspots along the agricultural frontier and in environmentally strategic areas, (4) strengthening investments in sustainable and resilient land use, and (5) improving institutional and community governance, especially for Indigenous Peoples and local communities [22]. The recent drop in the coca price has resulted in a humanitarian crisis in regions of Colombia affecting farmers who live in poverty as they have few, if any, alternatives to growing coca [28]. Examples of such regions in Colombia include Putumayo, a southern department where the Andes meets the Amazon, which borders Ecuador and Peru, and Cauca, a department in southwestern Colombia. Putumayo is adjacent to the southeastern part of Cauca [29–31].

One agricultural and economic alternative for farmers to growing coca in regions of Colombia where narco-trafficking and violence are prevalent is the indigenous seed called *sacha inchi* [32, 33]. *Sacha inchi* (*Plukenetia volubilis* L.), an Amazonian fruit tree, commonly referred to as “wild peanut,” “Inca peanut,” “Inca inchi,” or “mountain peanut.” *Sacha inchi* is widely distributed in South America, particularly in the Amazon River Basin in Peru

and Colombia [33]. In Colombia, *sacha inchi* cultivation has expanded to the southern regions of the country, including the departments of Putumayo, Caquetá, Meta, Guaviare, and Cauca, where it shows promising economic potential and offers possibilities for replacing illicit crops in conflict-affected areas [32, 33]. The chemical composition of *sacha inchi* varies depending on the plant part, with the seeds being of particular interest because of their high oil (35%–60%) and protein (27%) contents. The oil stands out because of its elevated levels of linolenic (ω -3) and linoleic (ω -6) acids, which account for approximately 45% and 35% of the total unsaturated fatty acids, respectively. In addition, essential amino acids such as cysteine, tyrosine, threonine, and tryptophan make roasted *sacha inchi* seeds and *sacha inchi* oil, which are highly valuable as functional foods owing to their nutritional value [34, 35]. *Sacha inchi* seeds also contain antioxidant properties. *Sacha inchi* is an “underutilized crop” in Colombia. Underutilized crops can increase agricultural hardiness, reduce the need for external inputs, provide climate resilience, enhance diet diversification, and improve income opportunities for smallholder farmers in Colombia [36].

Agroforestry can transform food systems in Colombia and around the world [37–39]. Agroforestry is a set of diverse land management systems that integrates trees and shrubs with crops and/or livestock in space and/or time. The climate mitigation potential of agroforestry is widely recognized [37–39]. In Colombia, agroforestry and silvopastoral systems [40–47] can mitigate the effects of climate change, contribute to peacebuilding and foster sustainable livelihoods through adopting coca-substitution crops, including cacao (cocoa) [47, 48]. These are key environmental, economic, and social benefits to society as armed conflict, violence, and narco-trafficking are drivers in land degradation and deforestation in Colombia [22, 46, 47]. According to the World Bank, Colombia: “Significant private investment opportunities also arise in agroforestry systems, irrigation and water management, and post-harvest infrastructure to reduce food losses and energy efficiency improvements along agricultural value chains” [22] (p. 25).

Silvopastoral systems—a type of agroforestry that integrates livestock, forage, and trees—can lower the carbon footprint of livestock per live weight [42]. In Colombia, adoption of silvopastoral systems has resulted in improved cattle profitability, reduced methane emissions from beef cattle, generated shade, and reduced heat stress of cattle. Based on these data, Sandoval and colleagues concluded that silvopastoral systems are a valuable option for climate change mitigation and adaptation [43]. Silvopastoral systems in the cattle sector can also promote circularity in food systems by creating the conditions for internal nutrient recycling, biological nitrogen fixation, phosphorus solubilization, and the presence of beneficial insects. In a circular food system, the use of finite and limited resources is minimized, and nutrients in residual streams and inedible biomass for humans are reused as inputs in a bioeconomy [44]. In Caquetá, a department located in the Colombian Amazonian region, silvopastoral systems have provided numerous benefits for farmers including increased milk production per cow and increased monthly farm profits [45]. A recently published review concluded that using agroecological approaches, such as silvopastoral systems, could assist in overcoming economic and ecological barriers to dairy farming in the northern Andean region of Colombia (e.g., Norte De Santander, Santander, Antioquia, and Boyacá) [46].

Subsidies and incentives to build food supply chains and improved access to land are also needed to transform Colombia’s food system [18]. “In the social sphere, vulnerable populations

may gain entrance to governance spaces where discussions about land access and use as well as fairness and stability in prices and access to better markets along a value chain take place” [40] (p. 3). Finally, conflict and violence, including gender-based violence, which affect women farmers, as well as gender inequality must be addressed to build food security and to facilitate a transition to a more sustainable food system in Colombia [49, 50].

2.2. Food consumption stage of the food system

At the consumption stage, there are multiple barriers to a creating a more sustainable food system in Colombia. Colombia has high levels of poverty, land and wealth inequality, and food insecurity [5, 51–53]. The drivers of household food insecurity in the Colombian population include (1) structural factors (monetary poverty, socioeconomic inequality, unemployment and working in the informal sector, and exposure to violence and conflict) and (2) temporary factors related to extreme climate conditions, the economic impact of COVID-19, the effects of the Ukraine crisis, and inflation [52, 53].

In a nationwide assessment of food insecurity in Colombia, it was determined that certain groups are more susceptible to food insecurity than other groups. Almost half of households who were victims of armed conflict were food insecure compared with 29% of households who were not affected by conflict or violence. Minority ethnic groups in Colombia including Afro-descendant or Indigenous Peoples experience high levels of food insecurity, 42% and 40%, respectively. Female-headed households experienced greater food insecurity (36%) compared with male-headed households (27%) [52]. According to qualitative data collected in this nationwide assessment of food insecurity in Colombia, individuals reported that their food intake had changed because of structural factors such as the abandonment of land due to safety concerns and fewer economic opportunities created by climate conditions and natural disasters. These factors resulted in households reducing their protein intake and increasing their carbohydrate intake. Most households reported that they consumed cereals almost daily (6.1 times/week) and had a relatively high consumption of meat (5.1 times per week) and eggs (3.4 times/week). The consumption of meats included highly processed meats such as sausages and ham. Colombian households’ consumption of fruits (2.7 times/week) and vegetables (2.3 times/week), which contain important sources of nutrients, was very limited—averaging below three times a week [52].

Because of poverty, inequality [5, 50, 51], and high levels of moderate-to-severe food insecurity [52, 53], food choices in Colombia are primarily linked to income, food affordability, and food accessibility [52]. Furthermore, traditional indigenous food systems are increasingly threatened by changing environments, global market forces, and colonization. This impinges upon the well-being of Indigenous Peoples, especially women and girls, who are disproportionately affected by poverty, hunger, and malnutrition [54]. These factors have contributed to a double burden of malnutrition [50]. A double burden of malnutrition is defined by the World Health Organization (WHO) as “the co-existence of undernutrition along with overweight and obesity or diet-related noncommunicable diseases, within individuals, households, and populations, and across the life course” [55]. As noted by the High Level Panel of Experts Committee on World Food Security, “Economic and market drivers have fundamentally changed food systems, by shaping market dynamics, flows of finance, and patterns

of global trade to consolidate decision-making power and ownership. These changes have altered dietary patterns in complex ways... While some nutritional benefits may accrue, there are concerns about the impacts of a transition towards a Western obesogenic diet, such as the exacerbation of food security and nutrition outcomes” [56] (p. xx).

In Colombia, 11.2% of children aged under 5 years are stunted, and 6.2% are overweight (including obesity). For children aged 5–19 years, 23% are overweight (including obesity). Rapid urbanization in Latin America, including in Colombia, has altered the availability of and access to nutritious foods and has influenced individuals’ dietary patterns through the exposure to obesogenic food environments [54]. A recent quantitative/qualitative study found that the main barriers to overweight and obesity prevention in Colombia were the obesogenic environment and the economic environment [57]. An obesogenic food environment is characterized by (1) high cost and lack of access, availability, and variety of healthy foods and (2) increased access, availability, affordability, and advertising and marketing of unhealthy foods, including ultra-processed foods and sugar-sweetened beverages (SBs). Repeated exposures to obesogenic food environments can influence food preferences and food choices, promoting unhealthy eating habits [54].

The industrialization of food and agriculture contributes to an increased reliance on commercial value chains for food purchases, resulting in an increased exposure and access to ultra-processed foods and beverages. This has contributed to the development of neighborhood-level “food swamps” or areas where there are few options for nutritious foods but several options for nutritionally poor foods [54, 58]. More specifically, a “food swamp” is a geographic location with a high concentration of fast-food restaurants and convenience stores compared with supermarkets and farmers’ markets. “Food swamps” are more prevalent in less affluent neighborhoods because ultra-processed foods are typically less expensive than perishable foods [54, 58]. This is important because research has shown that a high concentration of ultra-processed foods in people’s environments correlates positively with overweight prevalence in communities [58].

A recently published umbrella review and meta-analysis of observational evidence by Dai et al. [59] revealed that ultra-processed foods were associated with several negative health outcomes, “with renal function decline and wheezing in children and adolescents, showing convincing evidence (Class I); and five outcomes were reported as highly suggestive evidence (Class II), including diabetes mellitus, obesity, depression, and common mental disorders” (p. 1386–7). A study by Cediél et al. [60] revealed that in Colombia, a “significant positive association was found between the dietary share of UPF [ultra-processed food] and the content of [cardiovascular disease] CD-related nutrients such as free sugars, total fats, saturated fats, trans-fats and sodium. The prevalence of excessive intake of all [cardiovascular disease] CD-related nutrients (according to WHO recommendations) increased across quintiles of the dietary share of UPF. With the reduction of UPF consumption to the level seen among the 20% lowest consumers [1.0% (0%–4.5%) of the total energy from UPF], the prevalence of excessive nutrient intake was almost three-fourths lower for trans fats; around one third lower for free sugar and saturated fats, 26% lower for sodium and 15% lower for total fat” [60] (p. 1–2).

In 2022, Colombia adopted a tax that included both SBs and ultra-processed products (UPPs). This tax includes both SBs and “UPPs”, “following an advocacy campaign by Colectivo de Abogados José Alvear Restrepo (CAJAR), DeJusticia, FIAN Colombia, and RedPaz. The following year, in 2023, the Constitutional Court ruled that the tax is constitutional in response to a lawsuit by industry. The tax on SB [sweetened beverages] is sugar content-based and began implementation in 2023, with increases each year until 2025” [61] (p. 3).

Although it is too early to assess the impact of this tax on SB consumption in Colombia, a recent report by the Global Health Advocacy Incubator [61] noted that “Taxes on SBs [sugary beverages] have emerged as an important intervention for mitigating both the health and economic costs of these products. Governments can use taxes to reduce the consumption of these beverages, improve public health and generate revenues that can be used to strengthen sustainable health systems. Like other health excise taxes that impact population-wide consumption habits, SB taxes can contribute to health and economic equity across an entire country” [61] (p. 2).

Ultra-processed foods that are taxed in Colombia have front-of-package octagonal nutrient warning labels as is recommended by the Pan American Health Organization, which declare their high calorie, sugar, salt, and/or fat levels [62]. The ultra-processed foods’ tax in Colombia started at 10% before increasing to 15% in 2024 and to 20% in 2025. The ultra-processed foods’ tax was introduced alongside a tiered tax on SBs. Both the ultra-processed foods’ tax and nutrient warning labels have been introduced and implemented to address Colombia’s obesity crisis, as more than half of all Colombian adults are either overweight or obese [63].

One sustainable approach to increasing access to nutritious foods in neighborhoods with food swamps is to establish community food gardens [64, 65] based on the concept of Buen Vivir (Good living), a social philosophy based on harmony between nature and human beings, and a concept that is well accepted by many Indigenous communities in Latin America, including Colombia [14]. As reported by Farfan et al. [14], “Community support for native food production based on indigenous cosmovision and philosophy, alternative ethnobotany-based agriculture, indigenous seeds, medicinal and nutritional properties of native foods, and self-governance, such as the harvest and exchange of local produce, the incidence of nutritional policy, and control of the trade of external products, are some manifestations of indigenous resistance to food globalization. Some theoretical perspectives related to these notions include agroecology, decolonization, dialogue of knowledge and ‘Buen Vivir’ (Good living)” [14] (p. 1).

In Colombia, vegetable gardens are called *huertas* (in Spanish) [64]. Community food gardens in Colombia can be incorporated as a part of a systems of peri-urban and urban agriculture that can increase individuals’ access to healthy food, build food sovereignty, and serve as sustainable development. A case study on small-scale organic urban agriculture in Bogotá, Colombia, revealed that urban agriculture can serve as a form of sustainable development, exhibiting untapped potential for urban farming to address residents’ food requirements, build food security and food sovereignty, and address malnutrition [66]. Urban agri-food systems, including small-scale organic agriculture, can also reduce GHG emissions, reduce pollution, and curb plastic waste in urban farming. However, for such an approach to be effective,

interdisciplinary collaboration is necessary and effective prototypes need to be developed [66]. Furthermore, a recently published scoping review concluded that strategies for building Indigenous Peoples' food sovereignty and autonomy in Colombia should strengthen the ability of the communities to produce native food products [14].

Understanding a country's dietary patterns is an important factor in assessing how food systems impact food and nutrition security [67]. Sociocultural elements such as cultural traditions and food preferences influence dietary patterns as well [68]. The Colombian diet is based on staple foods such as rice, plantains, potatoes, and wheat foods that are easily available, accessible, and an important part of local food traditions. The diet is also characterized by a high intake of sweeteners (panela, sugar, and honey) and a low intake of fruits and vegetables [69]. Panela is a type of unrefined sugar that is produced and consumed in Latin America, including Colombia [70]. A high availability of animal-based proteins, and a lower availability of plant-based protein sources such as legumes and nuts, has resulted in most of the protein consumed coming from animal sources such as chicken, beef, and dairy [68]. The origin of calories consumed in Colombia has changed over time. This change has resulted in a shift in dietary patterns and an increase in the availability of animal proteins as well as animal and vegetable fats [67].

Using data obtained from the National Survey of the Nutritional Situation of Colombia of 2015, with a population aged 15–64 years, Meneses-Urrea et al. [67] reported four different dietary patterns in Colombia. The first dietary pattern is the “traditional pattern” characterized by dairy, potatoes/legumes, cereals, fried foods, coffee, panela/sugar/honey and meat/fish/eggs/sausages. The second dietary pattern is the “industrial pattern,” which includes packaged treats, fast food, and soft drinks. The third dietary pattern is the “conservative pattern,” which is made up of whole foods, light foods/supplements, fruits, and vegetables. The fourth dietary pattern is the “grilled food/processed drinks pattern,” which is made up of alcoholic beverages, grilled foods, and energy drinks. The authors concluded that these four different dietary patterns in Colombia are influenced by educational level, gender, chronic disease, and economic and social conditions rather than by residing in a certain geographical region of the country. There was a greater probability of following the traditional and conservative dietary patterns in individuals with diabetes and hypertension. The conservative dietary pattern was associated with being a woman, whereas the traditional dietary pattern was associated with being in the first and second wealth quartiles. Of the four wealth quartiles, quartiles one and two represent individuals who are the least wealthy. The grilled foods/processed drinks dietary pattern was more often reported in men than in women [67].

Elsewhere, it has been reported that “one in three people [in Colombia] does not consume fruit, five out of seven do not consume vegetables, one in four consumes fast foods, and one in five consumes sugary drinks every week” [18] (p. 5). “The per capita biodiversity impacts of Colombian diets are among the top five in the world and the per capita GHG [greenhouse gas emissions] are above what is required to meet [the 2015 Paris Agreement climate] targets” [18] (p. 3). Furthermore, in Colombia, 34% of all food is lost or wasted [71]. Fruits and vegetables generate the most food loss and waste, which produce GHGs in landfills where they end up. Therefore, incorporating a diet rich in fruits and vegetables not only enhances healthy eating habits but also plays a crucial role in reduced

food-related environmental impacts, including in reduction in GHG emissions [71].

The Global Foodbanking Network [72] reported that by rescuing food from farms and wholesalers and distributing it to those seeking food relief, food and groceries could be provided to 40 million people in 45 countries in 2023, simultaneously reducing food waste emissions, thereby avoiding approximately 1.8 million metric tons of carbon emissions. The same report concluded that by partnering with farmers, food banks reduced the amount of produce lost on farmers or after harvest by 35% [72].

In Bogotá, Colombia, the purpose of the Bogotá Food Bank is to promote food security, fight food waste, and simultaneously open paths to new market opportunities in rural areas [73]. Their mission involves more than the distribution of food. Rather, the mission of the Bogotá Food Bank is to eradicate hunger, strengthen the community, and build a more promising and equitable future for Colombia. To achieve its mission, the Bogotá Food Bank forges strategic alliances with private companies, academia, and civil society, to better serve the most vulnerable populations. Such alliances allowed the Bogotá Food Bank to deliver 17,909,903 kg of food to those who need and receive 10,545,811 kg in food donations from companies committed to ending hunger in 2023. Furthermore, 2,403,907 kg of fruits and vegetables were rescued, 268,722 kg of food waste was recycled, and 5,633 farming families received technical assistance [73].

The current Colombian diet, at the country level, exceeds planetary boundaries (ecological limits) for biodiversity loss, GHG emissions, grazing land use, water use, and eutrophication. To achieve diets within planetary boundaries, Colombians need to consume more legumes, nuts, and seeds, consume fewer root vegetables and tubers (starchy vegetables), and less red meat, including processed red meats, and sugar [74]. The recovery of food memory can be used to incorporate native, traditional, and indigenous foods back into the Colombian diet [75, 76]. Food memory is a process of intergenerational transmission of heritage that involves the verbal expression of food and food preparation practices, which produces the ability to remember how persons' ancestors in Colombia prepared culinary dishes and/or how they participated in culinary activities [77]. Native, traditional, and indigenous Colombian foods can also give sensory connotations to enhance new food options for more environmentally sustainable diets.

The food systems of Indigenous Peoples' are rich in biodiversity and their practices provide important insights on sustainable food practices. This knowledge can be leveraged to provide culturally appropriate foods to improve diets through interventions designed to identify nutritionally rich native, traditional, and indigenous foods. Such an approach can contribute to improving nutrition and health, reviving biocultural heritage, conserving biodiversity, and ultimately strengthening food sovereignty [14, 78]. In this sense, the faculty and students in the Department of Nutrition and Biochemistry of the Pontificia Universidad Javeriana, Bogotá, developed a project titled, “Seedbed for Research in Colombian Food, Nutrition and Biodiversity,” which involved the design of sustainable university menus using Colombian seasonings and foods.

2.3. Food system summary

In summary, there are various barriers to transitioning to a more sustainable food system in Colombia, including the expansion of

the agricultural frontier, especially the livestock sector, land grabbing (large-scale land acquisitions), the growing of illicit (illegal) crops and narco-deforestation, violence and armed conflict as well as marked inequities, particularly for minority ethnic groups in Colombia including Indigenous Peoples and Afro-Colombians, and female-headed households who experience high rates of food insecurity. The implementation of strategies such as community gardens, peri-urban and urban agriculture, and increased native food production have potential to enhance food security and food sovereignty. Such strategies are culturally appropriate as they are based on the concept of *Buen Vivir* (Good living). Other sustainable food system strategies include scaling up food producers' adoption of climate-smart agricultural practices such as agroforestry and silvopastoral systems as well as providing subsidies and incentives to agricultural producers to build food supply chains and improving access to land. There is also a need to increase the availability of and access to culturally appropriate foods including native and indigenous foods, which can facilitate the adoption of dietary patterns within planetary boundaries, revive traditional knowledge and foods, strengthen food sovereignty, and develop initiatives that reduce and prevent food waste, at institutional and consumer levels.

3. Conclusions

In conclusion, to facilitate the transition to a more sustainable food system and achieve food sovereignty in Colombia, the adoption of three key strategies is necessary. These strategies include: (1) consume a more varied diet where the plate represents the country's biodiversity by increasing plant-based proteins and fruits, and vegetables, and decreasing starchy vegetables, refined grains, animal-based protein, including fewer processed meats, and consuming fewer sweeteners and less sugar; (2) increase availability and accessibility to culturally appropriate foods while favoring climate-smart agricultural production practices such as agroforestry and silvopastoral systems; and (3) reduce food loss and waste to achieve a more efficient and equitable food system. Public health nutrition professionals can increase food security, build food sovereignty, and facilitate the transition to a more sustainable food system in Colombia through: (1) community-based gardening projects and peri-urban and urban agriculture projects; (2) institutional- and consumer-level food waste reduction and prevention projects; and (3) sustainable menu projects that incorporate indigenous, native, and local foods that facilitate the recovery of food memory. Such projects should be participatory and tailored to meet the needs of stakeholders in the different regions of Colombia.

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