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Global Trend towards Healthy Diets as a Mechanism to Promote Sustainable Food Security

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Abstract: This study aims to analyse the global trend towards healthy diets as a mechanism to promote sustainable food security, by reviewing the characteristics and importance of these patterns, assessing the cost of their supply chains, and identifying the requirements needed to achieve them. The study concluded that healthy dietary patterns are characterized by diversity, moderation and cultural resilience, and contribute to improving public health and supporting sustainable development, and that the shift towards these patterns requires a coordinated intervention that combines integrated public policies, reform of support systems, and investment in Infrastructure, supply chains, and community outreach within a rational institutional framework. The study recommended the adoption of integrated national strategies, redirecting support in favour of fresh food, investing in cold chains, enhancing food education, establishing governance structures for cross-sectoral coordination, and integrating climate adaptation into food systems.
Keywords: Healthy Diets, Sustainable Food Security, Supply Chains, Food Policies

Introduction:

Food is a basic human need, as it is inextricably linked to the health and well-being of societies. In today's rapidly changing world, increasing challenges to food systems have emerged, intersecting environmental, economic and social factors, making food security central to international agendas. With increasing pressures on natural resources, the worsening effects of climate change, and increasing rates of malnutrition in all its forms, it has become necessary to rethink the concept of traditional food security to include new dimensions It is related to sustainability and nutritional quality.

Despite the growing global awareness of the importance of the shift towards healthy diets, many countries continue to face difficulties in achieving this transition, especially in light of the high costs of supply chains, weak infrastructure, conflicting sectoral policies, and unequal access to nutritious food. This raises a fundamental problem: **how can the global trend towards healthy diets be an effective mechanism to promote sustainable food security, and what are the requirements to achieve this Existing economic, environmental, and institutional challenges?**

Importance of the research: The importance of this research is evident in the fact that it addresses a pivotal issue at the heart of sustainable development, as it links two basic

dimensions, namely food security and public health, at a time when the world is witnessing profound transformations in food production and consumption patterns. The research also contributes to providing an integrated framework to understand the relationship between global trends towards healthy diets and mechanisms to achieve sustainable food security, with a focus on applied challenges and the political, economic and institutional requirements necessary for this.

Research Objectives: This research aims to:

1. To analyse the concept of sustainable food security and healthy dietary patterns, and review their various dimensions and indicators.
2. Assessing the cost of healthy food supply chains, and the role of international trade and trade policies in determining food prices and availability.
3. Identify the prerequisites for achieving healthy diets at the political, legislative, economic, supply chain, social and awareness-raising, and institutional levels, and address the challenges of climate change.

Research Methodology: This research relied on the descriptive-analytical method, by reviewing and analysing the literature related to the concepts of sustainable food security and healthy dietary patterns, and the inductive approach was used to study the relationships between the different variables affecting the achievement of these patterns, relying on international reports issued by specialized United Nations organizations such as the Food and Agriculture Organization (FAO) and the World Health Organization (WHO), as well as relevant previous research and studies.

Previous Studies:

1- **Beal, T., et al. (2024),** Nutrient-dense foods and diverse diets are important for ensuring adequate nutrition across the life course, *Proceedings of the National Academy of Sciences (PNAS)*, National Academy of Sciences, Vol. 121, No. 23. The study confirmed that diverse diets rich in high-nutrient foods (such as vegetables, fruits, legumes, and nuts) contribute mainly to achieving food security and adequate nutrition, while improving overall health and reducing environmental impacts compared to diets based on low-nutrient foods.

2- **Tortladze, T. (2024)**. *The taste of sustainability: Comparing health and environmental outcomes of plant-based and Mediterranean diets* [Master's thesis, Università di Padova]. Università degli Studi di Padova Theses Repository. The thesis concluded that both the Mediterranean diet and the plant-based diet represent sustainable diets that achieve multiple health benefits (e.g. prevention of chronic diseases) with a significant reduction in environmental impact (greenhouse gas emissions and use of natural resources) compared to diets rich in animal products.

3. **Ben Khaznaji Khadija. (2013),** The Role of Economic Integration in Achieving Sustainable Food Security in the Maghreb Countries, Master's Thesis, University of Setif, 2013, The study concluded that the weak economic integration among the Maghreb countries, as a

result of political and administrative obstacles and the lack of coordination of agricultural policies, prevented the achievement of sustainable food security despite the available capabilities.

4. **Zighem, Djamila. (2026).** The Challenges of Achieving Food Security in the Maghreb Region: Algeria as a Case Study. *Afaq des Sciences*, 11(1), 614-622.The study found that structural food dependence, climate change represented by water scarcity and drought, and poor regional integration among Maghreb countries are the main constraints that limit the effectiveness of agricultural policies and prevent the achievement of sustainable food security in the region.

Research Divisions: To achieve the research objectives, the study was divided into three main axes:

1. The Concept of Sustainable Food Security and Healthy Diets
2. The Cost of Healthy Food Supply Chains
3. Requirements for Achieving Healthy Dietary Patterns

1. The concept of sustainable food security and healthy diets:

1.1. The concept of sustainable food security:

Below, you will try to understand the concept of sustainable food security, its various dimensions and indicators:

1.1.1. Definition of Sustainable Food Security:

The term sustainable food security has emerged in a new formula that keeps pace with the current changes, as food security has become required to be sustainable by taking into account the economic, social and environmental aspects, taking into account the right of future generations, i.e. ensuring a minimum of healthy food on a regular basis for the current and future generations, as it is defined as follows:

Sustainable food security is defined as "providing appropriate food for current generations in ways that do not place pre-constraints on future generations to enjoy the same or better amount of lunch (Khouri et al., 2011).

The International Committee on Environment and Development (ICED) has defined that "to ensure sustainable food security, we must rely on a continuous productive natural resource base, and the challenge facing governments and producers is to increase agricultural productivity, thereby ensuring food security while continuously enhancing the productive capacity of the resource base (Kamel Al-Aref, 1989) .

It is also defined as "providing a plan that ensures the optimal use of resources, to ensure production that covers all the needs of the people in quantity and quality of food, and that enables them to live in health and activity in accordance with their capabilities, taking into account the right of future generations to achieve the same level, whether through local production or imports based on their own resources" (Ben Khaznaji , 2013).

1.1.2. Dimensions of Sustainable Food Security:

According to the different definitions that have been presented about sustainable food security, we find that its concept involves several dimensions, the most important of which are the following (Muhammad Rafiq , 1999):

- **Time Dimension**: Any item that enjoys food security can continuously cover its needs, whether in the short term or in the long term, and this time distribution has depended on different methods of dealing with the problems related to the necessities of food security, where the methods, policies and procedures addressed the consequences of the lack or inability of food security for the community vary according to the time dimension that determines the framework of the crisis.
- **Quantitative dimension**: Food security means that the consumer has access to the right number of substances and nutrients, which cover his needs in a quantitative sense according to the courses of energy and nutrients based on the individual needs of the consumer.
- **Qualitative dimension:** In addition to the quantitative dimension, food security for consumers is not complete except by providing the qualitative dimension as well, i.e. the consumer's access to food of a certain quality, and the quality is related to the source of food from plant or animal origins, so we cannot judge the quality of consumption, the two groups of consumers consume the same amount of nutrients and energy except by knowing the sources of these elements, and the more the elements are of animal origin, the greater their biological value, because the biological value of animal protein is greater than that in the case of being from Plant origins.
- **Economic dimension:** Even if the required food is always available in the required quantities and quality, it cannot be said that sustainable food security is available unless people are able to access food supported by purchasing power that enables them to obtain and eat food at all times.
- **Social and political dimension:** Food is a basic human right, and achieving sustainable food security ensures that the subsistence limit is provided for all fairly. The absence of this limit or misdistribution leads to social and political instability, and the food deficit threatens internal security. Therefore, food is used as a more dangerous "green weapon" than a military weapon.
- **Environmental dimension**: The environmental dimension is one of the most important dimensions of sustainable food security, as the ecosystem represents the most important systems supporting the continuation of food security, and the promise of its availability leads to a decrease in food levels.

1.1.3. Sustainable Food Security Indicators:

There are several indicators and criteria that use knowledge and determine the level of food security in society, but these indicators have evolved according to the development of the concept of food security and can be divided into traditional indicators that define food security in the traditional concept in any society and modern indicators developed by the World Food Organization (WFO), which show us the extent of food sustainability.

1.2. The concept of healthy dietary patterns:

1.2.1. Definition of Healthy Diets:

Healthy diets refer to a type of diet that provides all the essential nutrients that the body needs to ensure healthy and sustainable growth. This diet includes eating a variety of balanced foods

that are rich in proteins, carbohydrates, healthy fats, vitamins, and minerals. The goal is to achieve a healthy balance between these elements to ensure that the body's energy and nutrition needs are met at various stages of life.

Dietary diversity and high nutritional density are key to ensuring adequate nutrition. Non-varied diets, even if they are adequate in calories, lead to deficiencies in micronutrients such as vitamin A, iron, and zinc, which weakens overall health and increases health burdens. Switching to fresh plant-based foods also reduces the environmental footprint compared to ultra-processed foods, and this intersects with the "environmental quality" characteristic of healthy diets (Beal, T., et al., 2024).

1.2.2. Characteristics of Healthy Diets:

1.2.2.1. Diversity and balance: The first principle is to diversify food and consume a wide range of foods from all food groups, such as vegetables, fruits, whole grains, plant and animal proteins, and healthy fats. Variety contributes to ensuring that all of the body's needs for micronutrients (such as vitamins and minerals) and macronutrients (such as proteins, carbohydrates, and fats) (FAO, 2024a).

1.2.2.2. Moderation: It means eating appropriate amounts of foods without excess. It is important to consume in moderation, especially foods rich in sugars, unhealthy fats, and salts, as consuming these ingredients in large quantities increases the risk of chronic diseases such as obesity and heart disease (FAO, 2019, pp. 1-150).

1.2.2.3. Energy Balance: A balance between calories consumed and daily activities is key to maintaining a healthy weight. Eat in sufficient quantities to meet the body's needs without gaining or losing weight (FAO, 2024a).

1.2.2.4. Environmental quality: In addition to influencing individual health, healthy diets also contribute to the preservation of the environment. According to global health organizations such as the World Health Organization (WHO) and the Food and Agriculture Organization (FAO), the transition to sustainable diets requires reducing excessive meat consumption and increasing the consumption of plant-based foods, which enhances the conservation of natural resources and reduces carbon emissions (FAO, 2019, pp. 1-150). Comparison of dietary patterns has shown that Mediterranean and vegan diets achieve a 35-50% reduction in greenhouse gas emissions and reduce water and land consumption, while improving the prevention of heart disease and diabetes. The Mediterranean diet is characterized by higher cultural flexibility, while veganism excels at reducing its carbon footprint, which necessitates choosing the most appropriate style according to the environmental and cultural context of each community. (Tortladze, 2024, pp. 45-47).

1.2.2.5. Resilience: Healthy diets are not necessarily fixed, but must be flexible according to the cultural, social, and economic contexts of different societies. This can include adapting the diet to local and traditional cuisines, contributing to its wider acceptance and spread in society (Harvard, 2012).

1.2.3. The importance of healthy diets:

1.2.3.1. Improve overall health: Healthy diets prevent many food-related diseases such as obesity, type 2 diabetes, and heart disease, as well as contribute to maintaining an ideal body weight and strengthening the immune system (FAO, 2024a, pp. 1-40) .

1.2.3.2. Supporting sustainable development: Promoting healthy diets contributes to the achievement of the Sustainable Development Goals (SDGs), especially the second goal (Zero Hunger, Food Security and Good Nutrition), which focuses on improving food patterns and reducing the environmental impacts associated with food production (FAO, 2024a, pp. 1-40) .

1.2.3.3. Impact on the economy: By improving public health and increasing productivity, healthy diets contribute to strengthening the national and international economy (FAO, 2024a, pp. 1-40) .

2. The Cost of Healthy Diets Supply Chains:

2.1. Production gaps and the role of trade in food diversity:

Production gaps arise as a result of the unequal distribution of natural resources between countries, as food production capacities vary depending on the availability of agricultural land, water resources, and climatic conditions. No country can produce all types of food efficiently throughout the year, creating an urgent need for international trade to fill these gaps. These gaps are clearly evident when comparing the productive capacities of different countries. China, one of the world's largest countries, produces about 120 different food items locally, while the small island developing nation of Kiribati produces only 15 terrestrial food items. This large gap does not reflect a lack of domestic effort as much as the limited natural resources available (IFPRI, 2024).

The past decade has seen a significant evolution in the role of trade in bridging production gaps. In 2010, the average number of foods available for consumption was about 60% higher than that produced locally, and by 2020 this proportion had risen to nearly 90%, meaning that trade is doubling the diversity of food available for consumption on average across countries. (IFPRI, 2024)

Table 1: Gap between domestic production and food available for consumption (country average, 2020)

Indicator	Number of food items
Locally Produced Materials	120
Materials available for consumption (after trade)	225
The gap that trade fills	105 Items

Reference: (FAO, 2024b, pp. 18-19)

The table shows the large gap between domestic production capacities and food available through trade, with an average of only 120 locally produced items, while rising to 225 items when imports are added, meaning that trade fills a gap of 105 food items (87.5% more than domestic production). This gap indicates that trade doubles the diversity of food available for consumption, and compensates for the limited natural resources that do not allow countries to produce all types of food locally, reflecting the vital role to trade in enhancing food security and the diversity of options available to consumers.

2.2. Trade Policies and Healthy Food Prices:

Trade policies, especially tariffs, directly affect domestic food prices and, consequently, the cost of healthy food supply chains. Trade liberalization and tariff reductions lead to increased competition and lower prices, improving consumers' purchasing power. The analysis suggests that higher tariffs are associated with higher prices overall, both for foods that are included in the healthy diet basket and those that are not. This means that trade liberalization leads to a proportionate drop in prices across all food categories, and does not disproportionately affect energy-rich and low-nutritional foods (IFPRI, 2024).

High-income countries import higher-cost food, while low- and middle-income countries import less expensive food, reflecting differences in quality, quality standards and transport costs. Prices also vary between countries due to differences in income, with higher purchasing power leading to higher commodity prices in high-productivity countries. While trade liberalization lowers prices and improves purchasing power, it can also lead to lower incomes for local farmers who are globally uncompetitive, necessitating balanced and mutually beneficial policies.

Table 2: The Impact of Tariffs on Food Prices

Tariff Level	Impact on Healthy Food Prices	Impact on unhealthy food prices
High	Rising prices	Rising prices
Low	Low prices	Low prices

Reference: (FAO, 2024b, pp. 25-26)

The table shows that tariffs uniformly affect food prices regardless of their healthy nature, with high tariffs driving up the prices of both healthy and unhealthy foods, while lower tariffs lower prices in both categories. This suggests that trade liberalization does not favour one food category at the expense of another, but rather its impact is proportionately reflected on all foods. Thus, concerns that trade openness will lead to a disproportionate decline in food prices Energy-rich and nutrient-poor (which may stimulate their consumption) is not supported by evidence, as the effect is almost equal on all food categories.

Figure (01): Distribution of food prices according to their inclusion in healthy food baskets according to the average level of customs tariff

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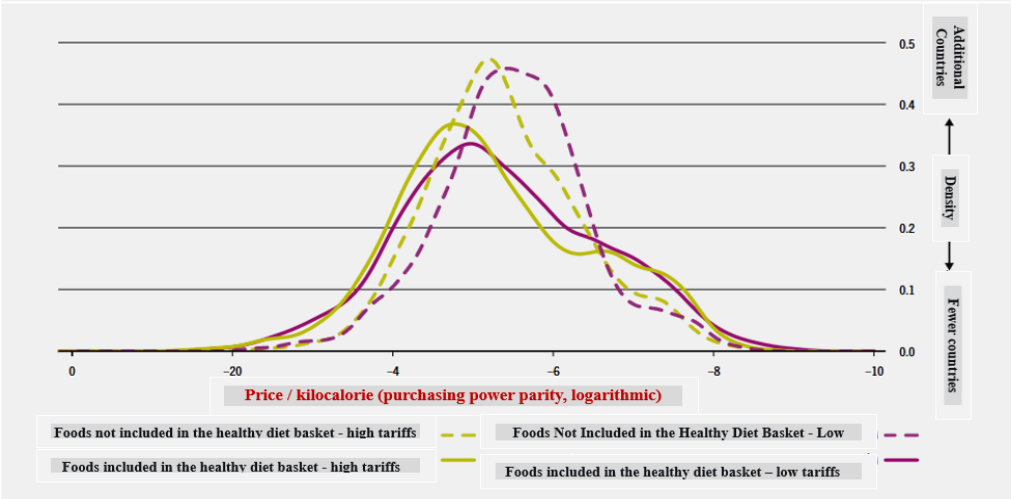

Source: (FAO, 2024b, p. 19)

The figure illustrates the direct relationship between the level of tariffs and food prices, where higher tariffs lead to higher prices and lower prices lead to lower prices, and more importantly, the distribution points of foods included in the basket of healthy diet (dark color) and non-included foods (light color) are distributed overlapping along the price axis without a clear separation between the two categories, indicating that tariffs affect all food categories proportionately, and do not lead to a disproportionate decrease in the prices of rich foods Energy-intensive and nutrient-poor. Thus, trade liberalization and tariff reductions reduce the cost of healthy diets as much as they do lower the cost of other foods, refuting fears that trade openness stimulates the consumption of unhealthy foods by selectively lowering their prices.

2.3. The Evolution of Global Trade and Supply Chain Costs:

Global trade in food products has witnessed remarkable development over the past two decades, with the volume of food trade more than doubling between 2000 and 2022. This expansion has been directly reflected in the availability, diversity, and cost of food in local markets.

Trade contributes to improved access to micronutrients such as vitamins and minerals. At the global level, food production provides an adequate supply of most nutrients, but their distribution is uneven. Gaps in many micronutrients have emerged in many countries, such as vitamin A, calcium and zinc. Statistical analyses indicate that there is a positive relationship between the openness of trade in food products and the adequacy of nutrient supplies between countries. Countries that are more integrated into global markets have a better capacity to fill gaps in micronutrients, especially in regions such as sub-Saharan Africa, which suffer from weak trade integration.

Figure (02): Evolution of trade by food category in the world during the period 2000-2021 (per capita energy content)

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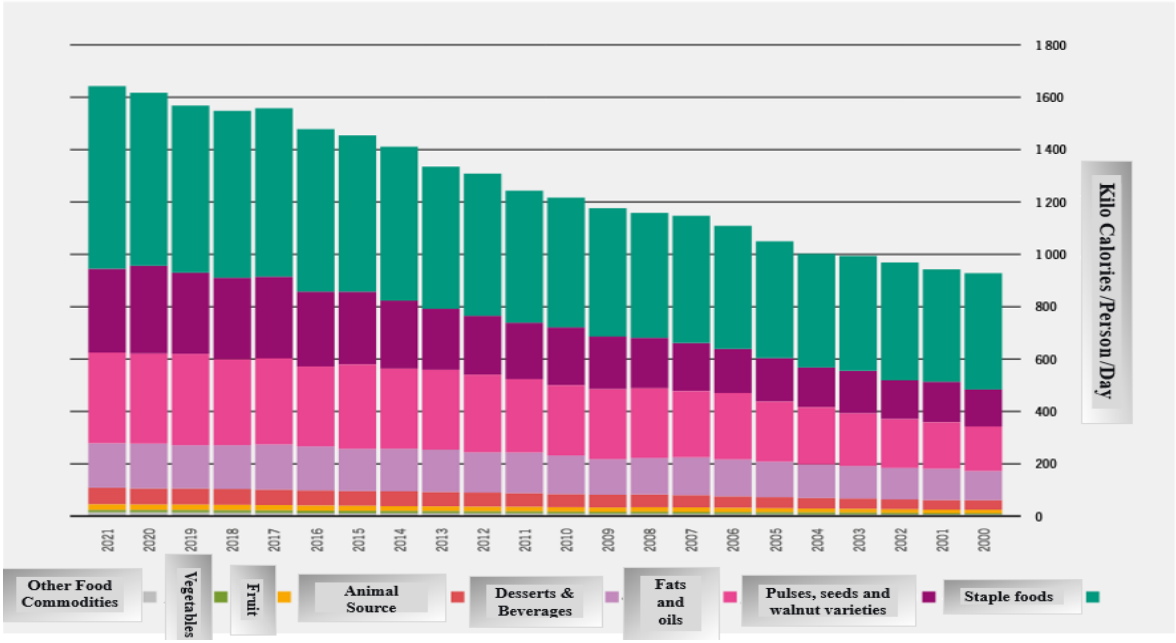

Source: (FAO, 2024b, p. 16)

The figure shows a continuous upward trend in trade in all food categories during the period 2000-2021, with the trade index rising from 100 to levels between 132 and 136, representing an overall increase of 32% to 36%. This increase is particularly important in the context of the cost of healthy diets, as the expansion of global trade is increasing the availability of food in domestic markets, lowering prices through competition, and improving access to diverse and nutritious foods. However, the gap between growth rates This increasing expansion of food trade in general is reducing the costs of supply chains, which is reflected positively on the ability of consumers, especially those with low incomes, to adopt more diverse and healthy diets.

3. Requirements for Achieving Healthy Dietary Patterns:

If the shift towards healthy diets is a pivotal mechanism to promote sustainable food security, this shift cannot be achieved spontaneously or through market mechanisms alone. It calls for coordinated intervention at multiple levels: public policy, infrastructure, community outreach, and food systems restructuring. In this context, the basic requirements for achieving healthy diets can be categorized as follows:

3.1 Political and Legislative Requirements:

3.1.1. Integrated National Food and Nutrition Strategies:

The World Health Organization (WHO) has launched the Global Food Safety Strategy 2022-2030, which aims to build national food control systems that are able to adapt to current and emerging challenges, with a focus on protecting the most vulnerable groups such as children under five (WHO, 2022).

3.1.2. Food subsidy reform and reorientation:

Reform of food support systems is an effective mechanism to catalyse the shift towards healthy diets, by shifting subsidies from highly processed goods and sugars to fresh, nutritious foods, and the 2021 FAO report emphasized the need to redesign support policies to enhance the resilience and resilience of agri-food systems (FAO, 2021, p. 87).

3.1.3 Legislation in Support of Health Options:

Required legislation includes taxes on sugary beverages, mandatory labeling of food information on packages (front labeling of packages), and regulation of the marketing of unhealthy foods to children. These measures have proven effective in countries such as Mexico and Chile in reducing the consumption of high-calorie and food-poor products, and evidence shows that the tax on sugary beverages in Mexico led to a 7.6% reduction in purchases of sugary beverages during the first year of implementation (Barry , et al., 2021).

3.1.4. Integration of sustainable food security into national plans:

Healthy diets should not only be seen as a health issue, but as a national priority for food security. The report of the High-Level Panel of Experts on Food Security and Nutrition (HLPE) recommended the need for an integrated approach that links agricultural, trade and health policies within a unified national framework for sustainable food security, and the report emphasizes that the lack of cross-sectoral coordination leads to policy contradictions that impede the achievement of nutrition goals (HLPE, 2020).

3.2. Economic Requirements and Supply Chains:

3.2.1. Stimulating short and local value chains:

Achieving healthy diets requires supporting local farmers and reducing intermediary rings to lower prices and increase profit margins for smallholder producers. Reardon and colleagues' study showed that the development of short supply chains improves access to affordable fresh food, especially in developing countries, and suggests that short value chains reduce fresh food losses by 15-20% compared to long chains (Reardone ,et al., 2021, p. 225).

3.2.2.2. Investment in refrigeration and storage infrastructure:

As healthy patterns rely heavily on fresh, perishable food, the absence of cold chains leads to post-harvest losses of up to 40% in some African countries, and the 2022 FAO report addressed the volume of food loss and waste and the importance of developing storage and refrigeration infrastructure as a priority to enhance food security (FAO, 2022).

3.2.3 Development of early warning systems and linking production to nutrition:

As the effects of climate change increase, it has become necessary to develop early warning systems that link agricultural production to nutritional needs. The 2023 Intergovernmental Panel on Climate Change (IPCC) Synthesis Report confirmed that climate change threatens the stability of healthy food supply chains, especially in areas most vulnerable to drought and flooding. (IPCC, 2023, p. 78).

3.2.4 Innovative financing for sustainable food systems:

The shift towards healthy diets requires the mobilization of significant financial resources through innovative public-private partnerships. In its 2023 report on the structure of food finance, the World Bank noted the need to develop climate finance mechanisms geared to sustainable food systems, including green bonds and impact investment funds (World Bank, 2023).

3.3. Social, Awareness and Cultural Requirements:

3.3.1 Nutrition education integrated into the school curriculum: Providing healthy food is not enough if it is not accompanied by consciously supported consumer demand. FAO recommends that healthy nutrition concepts be integrated into school curricula as a strategic tool for long-term impact on dietary behaviours for future generations, and FAO notes that school programmes that combine nutrition education with healthy meals in schools contribute to improving dietary habits by up to 40%. (FAO, 2021).

3.3.2. Consumer empowerment through awareness campaigns: Consumer empowerment through awareness campaigns is a key pillar for promoting public health, as these campaigns develop consumers' abilities to read and understand food labels, enabling them to consciously distinguish between healthy alternatives and make sound food choices. This approach is consistent with the concept of "dual task actions" proposed by Hooks et al. (2010) which emphasizes the importance of simultaneous interventions aimed at addressing all forms of malnutrition. Consumer education is an effective tool within this integrated strategy to enhance food and health security (Hawkes,et al., 2020, pp. 142-155).

3.3.3. Taking into account cultural dimensions and dietary diversity:

Consideration of cultural dimensions and dietary diversity is a pivotal element in promoting public health, as a healthy diet cannot be imposed in a uniform stereotype on different societies, but rather local traditional diets that have proven their health benefits over time, as these systems carry with them a cultural and social compatibility that increases the chances of adherence and sustainability. Some Studies have shown that the Mediterranean diet, which relies on traditional local ingredients, is associated with lower rates of chronic disease and improved Quality of life, which confirms that the integration of food heritage into awareness strategies enhances the effectiveness of health interventions and takes into account the specificity and nutritional diversity of communities (Trichopoulou, et al., 2014).

3.3.4. Promoting gender equality in access to healthy food:

Women play a pivotal role in achieving food security at the family level, and their economic and social empowerment is linked to improving children's dietary patterns and enhancing their ability to make healthy food choices. In this sense, the Global Nutrition Report emphasizes that promoting gender equality is a critical factor in achieving the global nutrition goals, as women's empowerment policies contribute to breaking the cycles of inherited malnutrition and improving health outcomes for future generations, especially when integrated into awareness programs Culturally and socially context-sensitive food (Global Report Nutrition, 2023).

3.4. Institutional and Governance Requirements:

3.4.1. Cross-sectoral coordination mechanisms: These variables require an institutional structure capable of cross-sectoral coordination, bringing together the Ministries of Health, Agriculture, Trade, Planning and Environment, within an integrated governance framework that ensures policy coherence and complementarity of roles. In its Food Safety Strategy 2022-2030, WHO adopts a multisectoral approach that promotes coordinated collaboration and aims to build evidence-based, people-centred, and cost-effective food systems, with appropriate coordinated governance structures and infrastructures, which represents An institutional model

that can be used in designing national coordination mechanisms to empower consumers and promote healthy nutrition (WHO, 2022).[1] The lack of regional institutional coordination due to political and administrative constraints and divergent agricultural policies impedes the achievement of sustainable food security, even with agricultural potential. Poor economic integration leads to duplication of efforts, high costs, and the inability of supply chains to provide healthy food at affordable prices. Regional governance structures for policy coordination and common early warning systems are therefore needed (Ben Khaznaji , 2013, pp. 78-80).

3.4.2. Integrated monitoring and evaluation systems: The shift towards healthy diets cannot be achieved without periodic monitoring systems for sustainable food security and nutrition indicators, which track changes in consumer behaviors, the quality of available food alternatives, and equal access gaps. The Global Nutrition Report provides an accountability and follow-up framework, by tracking progress towards global food goals and monitoring national and international commitments, it promotes transparency in performance and directs multisectoral coordination efforts towards the most pressing gaps, making it a vital tool for integrated monitoring systems (Global Report Nutrition, 2023).

3.4.3. Strengthening laboratory capacities and epidemiological surveillance: Institutional requirements include strengthening laboratory capacities for the surveillance of foodborne diseases, as a key pillar for early risk detection and rapid response to contamination and epidemic outbreaks, thereby contributing to protecting the health of consumers and ensuring the safety of food supplies. The WHO Global Food Safety Strategy 2022-2030 aims to strengthen these laboratory capacities along with epidemiological surveillance systems, as part of an integrated approach that links Risk analyses and periodic assessment of the performance of food safety systems, which is a critical element in enabling countries to achieve the transition towards healthy and sustainable food systems. (WHO, 2022, p. 35).

3.4.4. Building international and regional partnerships: Promoting sustainable food security requires close international and regional cooperation to share knowledge, techniques and experiences, standardize and coordinate efforts in the areas of monitoring and rapid response to transboundary risks. WHO and partner organizations have launched a joint framework for cooperation in the field of food safety, which aims to enhance synergies among different stakeholders and build strategic alliances that support countries in developing their national systems, which is a pillar are essential for achieving universal coverage of health and nutrition interventions in the context of sustainable food security (WHO, 2022, p. 48).

3.5. Requirements for adaptation to climate change and environmental sustainability:

3.5.1. Enhancing the resilience of food systems to climate shocks:

Climate change poses a growing threat to the stability of food systems, as frequent heat waves, droughts, and floods affect agricultural productivity, supply chains, and food quality, negatively impacting the availability, prices, and accessibility of healthy food. The Intergovernmental Panel on

[1] World Health Organization, WHO Global Strategy for Food Safety 2022-2030: Towards Stronger Food Safety Systems and Global Cooperation (Geneva: World Health Organization, 2022), 41, https://www.who.int/publications/i/item/9789240057685.

Climate Change (IPCC) Synthesis Report 2023 noted that food and water security is increasingly affected by climate change, necessitating the adoption of adaptive strategies that enhance the resilience of food systems through diversification of production sources and the development of Resilient value chains, integrating climate risks into food security and nutrition policies (IPCC, 2023).

One applied study shows that structural food dependence and climate change (water scarcity and drought) threaten healthy food supply chains, especially with weak irrigation, storage, and cooling infrastructure, increasing the spoilage and waste of fresh food before it reaches the consumer, and limiting the ability of local farmers to provide nutritious products at competitive prices. Strengthening climate resilience requires urgent investments in modern irrigation, cold chains, and diversification of import sources, along with reform of domestic production subsidies for high-density food Nutrition. (Zighem, 2026).

3.5.2Adopting low-emission food systems: Achieving environmental sustainability requires the adoption of food systems that reduce greenhouse gas emissions, by improving resource use efficiency, reducing food loss and waste, and shifting towards carbon-sensitive production and consumption patterns. The Intergovernmental Panel on Climate Change (IPCC) Synthesis Report indicates2023 suggests that changes in the food sector can significantly contribute to reducing greenhouse gas emissions, making food systems redesign a key pillar of climate change mitigation strategies, as well as enhancing their resilience to its impacts (IPCC, 2023).

3.5.3. Conservation of agricultural and food biodiversity: Agricultural biodiversity is the basis for healthy and sustainable dietary patterns, providing a wide range of nutritious foods that support human health and enhance the resilience of food systems to pests, diseases and climate change. The recommendations of the Intergovernmental Panel on Climate Change (IPCC) He pointed to the importance of effective conservation of lands, freshwaters and oceans, as vital ecosystems on which food systems are based, which calls for the development of integrated policies that protect the genetic diversity of crops and animal breeds, reduce the degradation of natural habitats, and promote agricultural production practices that preserve genetic resources for future generations (IPCC, 2023).

3.5.4. Enhancing resilience through diversification of sources of income:

Evidence suggests that diversifying farmers' and rural households' sources of income strengthens their resilience to climate and economic shocks, reducing reliance on a single source of income and providing a safety net that helps absorb the negative effects of shocks. Derrico and colleagues' study showed that households with diverse sources of income exhibit higher resilience to food insecurity, along with other factors such as education, access to land, livestock, and agricultural inputs, underscoring the importance of Design development interventions that combine enhancing agricultural productivity with alternative income opportunities in rural areas (d'Errico, et al., 2021).

Conclusion:

The research concludes that the global shift towards healthy diets represents a pivotal mechanism for achieving sustainable food security, with challenges that have gone beyond the traditional concept of quantity-based food security and access to a broader concept that includes environmental sustainability, food quality, social justice, and resilience. The analysis showed that this transformation cannot be achieved through market mechanisms alone, but rather requires a coordinated intervention that combines integrated public policies, reform of support systems, investment in infrastructure and supply chains, and awareness community, within a rational institutional framework and multi-sectoral

coordination. The findings also underscored the vital role of international trade in bridging production gaps and diversifying available food, with the need to design balanced trade policies that take into account the protection of the most vulnerable.

In the face of the challenges of climate change, it is important to strengthen the resilience of food systems and shift towards low-emission production systems that preserve biodiversity, while diversifying sources of income for rural communities. The shift towards healthy diets is not a strategic choice but an imperative that requires an integrated vision that combines political will, good governance, targeted investment, and community awareness, in a framework that recognizes that food sustainability is linked to the sustainability of health, the environment and development.

Results: Through the analysis carried out in various research axes, a set of key findings can be drawn, which we summarize as follows:

1. The concept of sustainable food security has evolved to include multiple dimensions (temporal, quantitative, qualitative, economic, socio-political, and environmental), with indicators varying between traditional and modern that take into account nutritional and sustainability dimensions.
2. Healthy diets are characterized by diversity and balance, moderation, energy balance, environmental quality, and cultural resilience, and contribute to improving public health, supporting sustainable development, and strengthening the economy.
3. Production gaps between countries arise as a result of the unequal distribution of natural resources, with trade doubling the diversity of available foods by 87.5% (from 120 to 225 foodstuffs) and their openness is positively correlated with the adequacy of micronutrient supplies.
4. Tariffs affect food prices uniformly, and trade liberalization contributes to lower prices, with the World Trade Index rising between 32% and 36% during the period 2000-2021.
5. Supporting policies and legislation require the adoption of integrated national strategies, reform of subsidy systems in favor of fresh food, and legislation that incentivizes healthy choices such as taxes on sugary drinks (which in Mexico led to a 7.6% reduction in consumption), and mandatory food labeling.
6. Short value chains reduce prices and reduce waste in fresh food by 15-20%, while losses due to the absence of cold chains can reach 40% in some countries, making investment in these infrastructures a priority.
7. Nutrition education programs integrated into the school curriculum contribute to improving dietary habits by up to 40%, and cross-sectoral coordination mechanisms and integrated monitoring systems are key institutional requirements.
8. Climate change poses a growing threat to the stability of healthy food supply chains, and diversifying rural communities' sources of income strengthens resilience to shocks.

Recommendations:

Based on the findings of this research, a set of recommendations can be formulated that target the various stakeholders to achieve sustainable food security and promote healthy diets, as follows:

- ✓ Develop multisectoral national strategies that combine food security, nutrition, public health and environmental sustainability goals, while redirecting government support from highly processed goods to fresh and nutritious food.
- ✓ Adopt legislation that stimulates healthy consumption, such as taxes on sugary drinks and mandatory food labelling, and include sustainable food security as a national priority in development plans.
- ✓ Support local farmers and develop short supply chains to lower prices and reduce losses, while investing in cold chains and storage facilities, especially in rural areas, and establishing early warning systems that link agricultural production to nutritional needs and climate risks.
- ✓ Designing balanced trade policies that benefit from international trade while protecting the most vulnerable, as well as developing innovative financing mechanisms such as green bonds and public-private partnerships to support sustainable food systems.
- ✓ Integrate nutrition education into school curricula, and launch awareness campaigns to enable consumers to make conscious healthy choices, taking into account cultural contexts and benefiting from traditional diets.
- ✓ Develop policies to empower women economically and socially for their pivotal role in household food security, while diversifying sources of income for rural communities to enhance their resilience.
- ✓ Establish national governance structures for cross-sectoral coordination, establish periodic monitoring systems for food security and nutrition indicators, strengthen laboratory capacities and epidemiological surveillance, and build international partnerships for knowledge sharing.
- ✓ Adopt climate change adaptation strategies that focus on diversifying sources of production and developing resilient value chains, while improving resource use efficiency, reducing losses, and protecting agricultural biodiversity.

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