Transition toward Sustainability in the Moroccan Food System: Drivers, Outcomes, and Challenges

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Abstract: Nowadays, food systems are undergoing major transformations to achieve the 2030 Sustainable Development Goals (SDGs). However, there are a lack of comprehensive reviews on this topic in developing countries. This work highlights food systems’ transition towards sustainability, focusing on Morocco. It was carried out through searching, selecting, evaluating, and synthesizing existing relevant scholarly and gray literature. In Morocco, a meaningful transition towards sustainability is being guided and carried out on several levels, despite numerous challenges, e.g., inability to cope with the detrimental effects of climate change and escalating water scarcity constitute fundamental problems. However, there are conflicting views on the outcomes of food system transformation. Some studies showed that Morocco has increased its agri-food export and reduced poverty to less than 5% of the population over the past decade; the proportion of wasted and malnourished children has declined from 25 to 15% and 4 to 3%, respectively, and the 2023 Global Hunger Index (GHI) showed a score of 9.0. Other studies showed that North Africa has entered a food security crisis; specifically, food inflation has reached unprecedented levels in Morocco. This paper provides valuable insights for policymakers and planners to design evidence-based policies and strategies to boost sustainable development in Morocco.

Keywords: food system; transformation; sustainable development goals; food security; sustainability; Morocco

1. Introduction

Nowadays, the agri-food sector is experiencing a flurry of activity around food security and the transition to sustainable food systems is a subject of discussion [1]. The initial usage of the phrase “food security” occurred in 1996 during the FAO Rome International Food Summit to describe the situation where “all people, at all times have physical and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life”, and food security is officially acknowledged as a fundamental human entitlement [2]. However, the current food supply chain contributes to the increasing prevalence of food insecurity in several nations [3]. Not to mention, it wrecks havoc on the ecosystem, and so on [1]. Prior to the start of the COVID-19 outbreak, which caused supply-chain disruptions and diminished incomes, chronic and acute starvation were already increasing as a result of a multitude of factors including climate change, pests, conflicts, socioeconomic conditions, and natural disasters. The ongoing conflict in Ukraine exacerbates the current predicament by introducing uncertainty regarding food prices, which are projected to persist at elevated levels indefinitely and force millions of additional individuals to confront severe food insecurity [3]. This situation is jeopardizing humans...
and the planet, today and tomorrow, especially with the ever-increasing global population expected to reach 10 billion people in 30 years [4].

The urgency to transform our food systems is now irrefutable [5]. It is time to create sustainable and resilient food systems. This intervention has the potential not only to alleviate starvation but also facilitate significant advancements towards all seventeen SDGs [6]. Specifically, SDG 2, which aims to eradicate famine, enhance nutrition, attain food security, and advance sustainable agriculture, is interconnected with the other SDGs. The 169 targets have been formulated to serve as a road map to attain a more sustainable and favorable future for all nations [7], developed and developing ones alike.

There is a growing interest in evaluating the current food systems’ sustainability worldwide. Going forward, many food systems are already undergoing major transformations aiming for sustainability. However, there is a lack of scientific literature reviews on this topic in developing countries such as Morocco. Indeed, a search carried out on the Web of Science—using the following query: “food system” AND Morocco AND (transition or transformation) and (sustainability or sustainable)—returned only one document, namely El Ghmari et al. [8]. This shows the marginality of the topic in scholarly literature and, consequently, the impossibility of carrying out a systematic review. For that, this paper combines scholarly literature, retrieved from different sources, and grey literature (e.g., reports, policy documents). It aims to compile—in one review paper—basic information about food system transformation towards sustainability in the world, focusing on Morocco; it addresses the key drivers, interventions and achievements, challenges, opportunities, and outcomes.

2. Food Systems: Concept, Components, and Sustainability

The notion of food systems has emerged as a key element in food policy, serving as a guiding framework for strategic deliberation aimed at attaining a wide range of safe and nutritious food for everyone [9]. Food systems consist of a comprehensive network of collaborators and their interrelated value-adding endeavors that traverse the entire lifecycle of food products, starting from farm to plate sourced from forestry, agriculture, or fisheries. These systems are integral components of the larger economic, social, and environmental environments in which they operate. The food systems consist of subsystems that engage in interactions with other critical systems, such as the energy system and input supply system [10]. Alternatively stated, the food system comprises various components, such as food supply chains, individual determinants, food environments, consumer conduct, and external drivers—determinants that exert pressure or attraction on the systems through their impact on individuals’ dietary patterns, nutritional status, and overall health results [11].

Transportation and production are all components of the food supply chain, which spans from the field to consumption. The individuals comprising food supply chains include producers, processors, distributors, haulers, and retailers [12]. Each component of the food supply chain functions as an interconnected system. Alterations to one stage have an impact on subsequent steps in the chain. Processing and other supply-chain operations have an impact on the cost-effectiveness and nutritional value of a food product. Scales and levels of operation vary throughout food supply channels, contingent upon the food system. Short food supply chains may be prevalent in rural and isolated communities. Large urban areas often have longer and more intricate food supply chains, with food production occurring at greater distances and involving a greater number of people in the stages of processing, packaging, and retailing [13,14]. However, food supply chains are currently experiencing swift changes, especially in low-income and middle-income nations. This frequently leads to increased interdependence among actors in these rural and urban environments [15].

The food environment pertains to the context whereby individuals procure and ingest food in conjunction with the food system. The food environment includes tangible locations such as shops or marketplaces. In addition, it encompasses social, economic, and cultural
aspects. The food environment encompasses the presence and accessibility of food, its cost-effectiveness, as well as its safety, quality, and comfort. Additionally, advertising also plays a role in shaping the food environment \[13,14,16\]. The attributes of the food environment impact individuals’ dietary choices by shaping their access to food \[11\].

Personal determinants such as financial status, cognitive processes, ambitions, and life circumstances influence an individual’s food selection and consumption. Income can determine affordable dietary options, while environmental consciousness and nutritional status can influence purchasing habits. Work or domestic environments also impact the time available for food preparation. The way individuals engage with their food environment ultimately determines their food choices and consumption \[11\].

Consumer behaviors consist of individuals’ selections of food items, as well as their practices regarding food preparation, storage, consumption, and domestic food sharing. Additionally, individual and environmental factors impact consumer behavior. A substantial amount of rigorous research has been conducted on consumer behavior; however, there is a lack of internationally and nationally accepted key indicators of consumer behavior \[11\].

A sustainable food system ensures that the environmental and socioeconomic foundations for providing and preserving nutritional resilience, food security, and nutrition for forthcoming generations while ensuring that all individuals have access to nutrition and food security \[12\]. In order to be economically viable, provide equitable and balanced societal benefits (social sustainability), and maintain a positive or neutral environmental footprint (environmental sustainability), sustainable food systems must yield favorable outcomes across the three dimensions of sustainability \[12\].

A holistic approach is taken to the development of a sustainable agricultural system. Concurrently generating beneficial advantages in the socioeconomic and environmental spheres is essential for sustainable food system development. When every action conducted by a participant in the food system or a supplier of assistance is financially or economically feasible, the food system is deemed sustainable from an economic standpoint. Benefits to laborers, taxes to governments, profits for businesses, and an enhanced food supply for consumers are all categories of constituents for whom the activities ought to generate economic added value. When added economic value is distributed equitably, considering vulnerable groups classified by gender, age, race, and other factors, a food system is deemed sustainable on the social dimension \[12\].

Anthropogenic endeavors within the food system ought to enhance sociocultural outcomes such as health, nutrition, labor conditions, and animal welfare. By ensuring that food system activities do not have adverse effects on the natural environment, including carbon and water emissions, food loss, pollution, animal and plant health, and biodiversity, environmental sustainability is achieved \[12\].

3. Food System Transformation

Intentional and substantial modifications to any component of the food system constitute food system transformation \[17\]. Such changes not only increase the affordability of nutritious diets but also strengthen the system’s resistance to the causes of food insecurity and malnutrition \[18\].

3.1. Drivers

Drivers are considered to be factors that strongly influence the evolution of future scenarios. They include climate change, globalization, income growth and socio-economic development, urbanization, population growth, policies, and socio-cultural traditions. Ongoing economic recovery and increasing incomes, rapid urbanization, consistent population growth, intensifying globalization, and digitalization are the primary forces propelling food system transformation in Africa \[19\].

In recent times, food systems have been significantly impacted by a range of transformative developments. These include economic and social transformations (such as the rise of middle-income earners in developing nations, swift demographic expansion, and urban
development), technological advancements (such as the increased use of information and communications technology and robots), climatic fluctuations, and depletion of natural resources [20]. Although population growth stimulates farming activities and increases the demand for agricultural products, urbanization necessitates food that is readily transportable and stored. Food processing has therefore emerged as a significant catalyst in the evolution of food systems. It has also resulted in the consolidation of farmland and the standardization of agricultural output, which has frequently led to a centering of primary production. The urbanization process has been accelerated by the migration of numerous small-scale farmers in search of employment or landless agricultural laborers to cities and municipalities [21].

Food insecurity is likely to worsen as a consequence of unmitigated climate change. Climate changes may result in reduced marine populations and crop yields at the production level of the food system [17]. Core crops cultivated at elevated CO\textsubscript{2} levels may exhibit less nutrient content, hence impacting the nutritional value of individual diets [14,17,18,22]. In the storage and distribution phase of the food system, climate change leads to more crop losses due to increased susceptibility to diseases and extreme weather events [22]. Food costs might increase as a result of agricultural losses and reduced crop production.

As a result of globalization, nations and individuals are becoming more interdependent and interconnected. It shapes local economies and exerts both beneficial and detrimental impacts on human well-being and nutrition. While trade has the potential to generate employment opportunities, it can also intensify competition among domestic producers, thereby posing a threat to smallholders’ livelihoods and potentially resulting in decreased prices for local goods [23,24]. Trade can facilitate access to foods that are scarce during a particular season or difficult to cultivate in one’s region. This practice enhances the variety of food available and ensures year-round access to seasonal cuisines. Additionally, it produces commodities at a reduced cost by utilizing efficiency and competition [14]. Enhanced affordability of imported food and feed can facilitate greater accessibility to animal-derived foods and promote increased protein consumption, a critical factor in regions afflicted by severe malnutrition [24]. Furthermore, diets and nutrition may be adversely affected by globalization and commerce. Commercial practices and pervasive advertising have contributed to the increased availability and affordability of unhealthy foods on a global scale [23–25]. An increase in the consumption of particularly industrialized foods that are high in added carbohydrates, sodium, and harmful lipids, as well as minimally processed foods, has replaced the traditional emphasis on such foods in people’s diets. Inactivity is also declining among the populace [26]. Increased prevalence of overweight and obese people and noncommunicable diseases have resulted from each of these alterations [11].

Nutrient-dense foods (e.g., fruits, animal-based products, and dairy items) become more readily available as the average income of a nation increases. Additionally, an increase in income can lead to a surge in the demand for animal-based foods, which can strain food systems through increased greenhouse gas emissions and demands for land and water resources [14]. Individuals with a higher income may also purchase more unhealthy foods, including carbonated beverages and packaged foods that are highly processed [27,28]. Further income inequality could potentially result in unequal access to nutritious foods. Fresh fruits and vegetables, as well as other unprocessed and packaged foods, tend to be more costly in high-income nations. Highly processed and animal-based foods are often linked to affluence in low and middle-income nations, potentially influencing the social desirability of these foods [14,29].

A country’s food system is shaped by urbanization, which restricts agriculture and produces extended food chains. Due to the increased demand for processing, packaging, and refrigeration, as well as the greater amount of food that is lost, urban areas are frequently hubs for food technology innovation [14]. By increasing the number of supermarkets in a given region, urbanization regulates the food environment. Access to both healthy and harmful commodities may be expanded with the addition of more supermarkets [30]. All foods, including a greater variety of processed foods, are more readily available due to
urbanization. Whereas supermarkets hinder access to food in low-income and middle-income nations, street vendors provide it. Urbanization can result in the settlement of low-income individuals in wetlands and food deserts. Unhealthy fast foods and highly processed packaged foods are prevalent in these regions, whereas access to fresh and nutritious foods is limited. Income growth, increased demand for convenience foods, and dining out are additional factors associated with urbanization [14]. The utilization of urban–rural connections to stimulate rural economies and expand the population’s access to nutritious nutrition is gaining increasing interest [31].

It is projected that the global population will increase by over 2 billion individuals between 2017 and 2050. Population growth is anticipated to be the most rapid in countries located in Asia and Africa [32]. The current agricultural infrastructure will be subjected to greater strain as the population grows. Population growth in one country can have an impact on the agricultural systems of other regions as a result of immigration and global trade. Furthermore, an influx of migrants escaping extreme weather or conflict may find unprepared nations. It may not be possible for food systems to furnish a nutritious diet for every individual [13,14].

Food systems are impacted by legislation concerning agriculture, nutrition, and commerce. In turn, dietary intake can be influenced by economic policies concerning agricultural trade and subsidies, which impact the accessibility and cost-effectiveness of specific food items [31]. To promote healthful diets and shape policy, governments may enact dietary guidelines. One potential application of tax policies is to disincentivize the consumption of detrimental food items, such as beverages and packaged foods that are heavily processed. To guarantee adequate resources for the establishment of a sustainable agricultural system [14], political determination and financial investment are necessary [14].

Food supply chains are influenced by social and cultural traditions, which determine the preferences for particular cuisines, the timing and methods of meal preparation, and the practices that are maintained. In some cultures, a person’s social standing within a community or family may be reflected in their cuisine. Foods associated with individuals of greater economic status may be more coveted. Food is a fundamental component of holidays and traditions in the majority of cultures. Resistance to the adoption of fast food and a preference for diets high in processed foods can be thwarted by robust cultural connections to traditional foods and meal practices. Particular food items are abstained from in numerous cultures due to factors such as gender or life stage. Culture significantly influences the dietary choices of individuals, especially those who are pregnant or lactating [14].

3.2. Outcomes

Dietary patterns are health and nutritionally significant and are impacted by each component of the food system. A nutritious diet begins early in life and consists of a variety of foods, according to the World Health Organization (WHO). This includes carbohydrate staples, legumes, fruits and vegetables, and animal products (e.g., dairy and meat). With a healthful diet, energy expenditure and intake are in balance, and sodium, fat, added sugar, highly processed foods, and sugar-sweetened beverages are restricted [33]. People continue to lack sufficient calories and a diversity of nutritious, nutrient-dense foods on a global scale. This dearth of access results in micronutrient deficiencies and malnutrition. The availability and accessibility of nutrient-dense foods, including fruits, vegetables, and seafood, have been enhanced by rising incomes. However, rising incomes and globalization have also contributed to an increase in the consumption of harmful foods [13,34], including highly processed foods and sugar-sweetened beverages. In addition, consumers, policymakers, and researchers are placing a greater emphasis on the environmental sustainability of nutrition [35]. Diets and food systems have a substantial impact on greenhouse gas emissions and the utilization and depletion of water and land resources [11].
For proper nutrition and health, healthy diets are essential. Worldwide, inadequate dietary habits constitute a significant hazard of death [36]. Poor nutrition, which is linked to impaired cognitive development and increased vulnerability to infections, is a significant contributor to disease and a primary risk factor. Micronutrient deficiencies can be induced by diets deficient in vital nutrients. In addition to noncommunicable diseases like cardiovascular disease and diabetes, diets that surpass the recommended energy intake, especially those comprised of unhealthful dietary patterns, may contribute to weight gain and obesity. A significantly elevated mortality risk is associated with diets that are rich in sodium and deficient in omega-3 fatty acids, whole cereals, seeds, fruits, and vegetables [36]. Additionally, the health of consumers and food system employees is impacted by pesticide use, food safety, and antimicrobial resistance [12].

Global and local environments are impacted by food systems. Worldwide food production contributes to approximately 19% to 29% of total greenhouse gas emissions, which exacerbates climate change [17]. Environmental impacts are distinct for various food production methods. Particularly detrimental to the environment is the production of ruminant flesh and dairy products, which is contingent upon the production method employed in various contexts. Large quantities of water and land may be required for production, which may also generate substantial greenhouse gas emissions. More pesticides and fertilizers are required for intensive agriculture. In addition, monoculture and the production of commercial crops can contribute to the loss of biodiversity. This can degrade the soil and reduce the resilience of the agricultural system to drought and other extreme weather events [14,37].

The agricultural system is one of the most significant employment sectors on a global scale. The agricultural sector serves as the primary economic driver for low-income and middle-income nations. Problem modifications and alterations in food systems can exert substantial economic influence on retailers, consumers, and producers [14]. Increases in imported food products, for instance, could result in decreased production of local staples and increased competition among smallholder farmers. However, assistance to export-oriented sectors could potentially result in a surge in cash crop generation among domestic producers. Additionally, trade can spur increased investment in the technology and agricultural industries, thus creating new jobs [23,24].

Food systems are vital to the well-being of a community; they contribute to the assurance that every member is in the best possible health. Food systems can contribute to this objective by ensuring that every member of society has an equal opportunity to consume a nutritious diet. They can also ensure that employees of the food system are employed in safe, well-paid environments. Equitable food systems contribute to the advancement of animal rights, labor rights, gender equality, and societal health [14,38].

Advancements in food systems have generated numerous favorable outcomes, predominantly in developing nations. The development of food industries has resulted in the expansion of off-farm employment opportunities and a broader selection of foods beyond regional staples, thereby catering to consumers’ inclinations regarding flavor, appearance, and excellence. Nevertheless, the swift structural changes that have ensued as a result have given rise to mounting and substantial obstacles, which may have far-reaching implications for the condition of nutrition and food security. The issues at hand encompass a variety of concerns. These include the widespread availability and consumption of food items that are highly processed, high in calories, and lack nutritional value; the restricted market access for small-scale producers and agricultural enterprises; the significant quantities of food wastage; the increase in food safety incidents, and animal and human health issues; and the intensified energy consumption and environmental consequences that arise from the industrialization and growth of food supply chains [39].
4. Food System Transformation in Morocco

4.1. Interventions Made for Transformation and Main Achievements

Below are the different types of interventions (institutional, political, programmatic) that have been undertaken to transform the food systems in Morocco towards sustainability. Some achievements are also shown.

4.1.1. Institutional Innovations

Numerous organizations strive to reform the agricultural systems of Morocco. The commitment to supervising the formulation and execution of national directives concerning rural and agricultural advancement primarily rests with the Ministry of Agriculture and Fisheries. However, this task is executed in collaboration with the Agricultural Development Agency (ADA) and the Regional Offices of Agricultural Development (ORMVAs). Furthermore, Morocco has institutions aimed at stimulating private sector investments, facilitating farmers' financial accessibility, augmenting extension service provision, enhancing food safety, and generating employment opportunities within the agri-food industry.

Several institutions provide decentralized and targeted services to transform food systems in Morocco:

- Founded in 1966, the ORMVA has a major influence in transforming food systems through its regional agricultural development initiatives, especially by modernizing the irrigation system; this includes the development of efficient irrigation techniques such as drip and micro-sprinkler systems, which help optimize water use and improve crop yields. The ORMVA has implemented projects to improve water-use efficiency in agriculture; this includes rehabilitation and maintenance of existing irrigation infrastructure to minimize water wastage and improve the reliability of water delivery [40]. In addition, this office integrates climate-smart agriculture practices into its development projects; this involves promoting resilient crop varieties, soil conservation techniques, and agroforestry to improve agricultural productivity in the face of climate change. Furthermore, the ORMVA has helped increase agricultural productivity and improve the income of smallholder farmers; this is achieved through better access to inputs, improved market linkages, and capacity-building programs [41].

- Founded in 2009, the ADA plays an important role in the modernization of agricultural infrastructure in Morocco. This includes improving irrigation systems, improving water management practices, and promoting sustainable agriculture techniques [41]. This agency implements programs to support smallholder farmers by providing access to credit, technical assistance, and training in modern agricultural practices. This helps improve productivity and income levels in rural communities. It also assists investors interested in entering the agriculture industry by furnishing them with information, counsel, and direction on project selection [42]. Additionally, the ADA facilitates the integration of smallholder farmers into market value chains by fostering market linkages, improving post-harvest handling practices, and supporting agribusiness development [40].

- Established in 2013, the National Office for Agricultural Advice (Office National du Conseil Agricole, ONCA) plays a crucial role in advising and supporting agricultural development, contributing to the transformation of the country’s food systems. ONCA provides extensive advisory services and technical support to farmers throughout Morocco; this includes training programs, workshops, and demonstrations aimed at promoting modern agricultural practices, improving productivity, and adopting sustainable farming methods. The office has embraced digital technologies to enhance agricultural extension services; this includes using mobile applications and online platforms to provide agricultural information, weather forecasts, market prices, and best agricultural practices to farmers [40]. In addition, the ONCA promotes climate-smart agriculture practices among farmers, focusing on resilience to climate change, water management, soil conservation, and the use of drought-resistant crop varieties [41].
• Founded in 2009, the National Office of Food Safety (Office National de Sécurité Sanitaire des produits Alimentaires, ONSSA) monitors and protects the animal and plant heritage of the country at the national level and the borders. The office ensures food safety from primary products to the final consumer, including fish products and animal feed. It provides registration and inspection of agricultural inputs and registration of veterinary drugs. ONSSA applies phytosanitary and veterinary policies, laws and measures and provides risk assessment [43].

The financing and functioning of Morocco’s food systems are ensured by many institutions/tools:

• Founded in 1986, the Agricultural Development Fund (Fonds de Développement Agricole, FDA) endeavors to stimulate privately funded investment in agriculture. To achieve this, it offers targeted motivators, including financial support, that encourage the adoption of irrigation and enhance the yield of vegetables and fruits. Additionally, it develops downstream activities and improves breeding practices to bolster the performance of the cattle sector [44]. Thus, the FDA functions as an instrument for executing governmental policies in the agricultural industry and as a mechanism to stimulate ventures [45]. In the year 2019, the budgeted encouragement totaled MAD 8.6 billion, and farmers owning less than 10 ha accounted for 58% of the recipients. FDA expenditures increased to MAD 9.7 billion within 2020 and are anticipated to surpass MAD 10 billion in 2021 [46].

• Founded in 1949, the Credit Guarantee Corporation (Caisse Centrale de Garantie, CCG) of Morocco is considered a state instrument. It contributes to boost private initiatives by encouraging the creation, development, and modernization of companies. Additionally, the CCG supports social development through guaranteeing loans for housing [47].

• Founded in 2010, Tamwil El Fellah (TEF) was originally established as the Banque de Développement Agricole (BDA), which was formerly known as the Credit Agricole Group of Morocco (Groupe Credit Agricole du Maroc, GCAM). Small producers are eligible for collateral-free financial services through a partnership between the GCAM and the Moroccan government. About 25% of the farmer’s income, was established as the loan limit. Inputs and working capital may account for no more than 20% of the total, while other investments may account for no more than 80%. TEF, on the other hand, offers a partial guarantee program under which the government insures 60% of the risk. To accommodate the lengthier and more seasonal nature of agricultural finance, adjustments have been made to the loan term. GCAM has expanded its client base and improved risk management by prolonging the periods in which loans are deemed pre-doubtful, doubtful, and compromised [48]. TEF also promotes productivity and enhances low-risk investments, such as in mechanization and irrigation, through facilitating credit for these investments. The financial services are complemented by technical assistance [49]. By 2015, the operations of TEF had reached break-even point. By 2016, more than 67,000 smallholders had benefited from loans, and the loan repayment rate at the end of the term was 98%. About 70% of the loans had been granted to finance investments in dairy production, irrigation, agricultural equipment, and tree planting [50]. Particularly popular reasons for borrowing included the conversion of crops towards higher value-added production like olives, almonds and figs, diversification towards off-farm and processing activities, and intensification. Interestingly, as of October 2015, more than 1800 irrigation projects using solar water pumping systems have also been funded. The model was so successful that it has also been extended to small and medium-sized enterprises (SMEs) [48].

• Founded in 1963, the Mutual Moroccan Agricultural Insurance Company (Mutuelle Agricole Marocaine d’Assurances, MAMDA) is a significant agricultural insurance company in Morocco. MAMDA and the Moroccan government have formed a public-private partnership to manage Morocco’s agricultural insurance program, which covers a wide range of climatic and agricultural risks. MAMDA offers multi-risk
climate insurance coverage for large crops in three agricultural zones and 10 regions of Morocco, with five levels of insured capital, and also manages, on behalf of the State, a multi-risk guarantee fund for fruit trees. For the first insurance product, a range of insurance amounts and subsidies are offered for the 15 possible zone/level combinations. Eligibility for payment of claims is officially declared when the yield of insured crops falls below 60% of the average yield of the previous 10 years in a rural municipality. Designing and operating this insurance system is very complex. Only 17% of farmers are insured in Morocco (with the reduction in cereal areas in recent years, this rate has increased to 40%). Insurance mainly covers large farms: while 40% of large farms (>50 ha) are insured, this is the case for only 24% of medium farms (10 to 50 ha) and less than 3% of small farms (<10 ha) [51].

- By leveraging educational and training institutions, a network of 52 institutions has been created in Morocco with 24 different curricula across the country to improve the uptake and efficiency of agribusiness. Furthermore, eight secondary schools prepare young people to obtain a baccalaureate degree in agricultural sciences in addition to 30 middle schools in rural areas dedicated to training young people in agricultural technology. All agricultural vocational training institutions provide vocational training to improve employment opportunities for rural youth who are not in school, but have basic literacy skills. Every year, 10,000 young people receive retraining in 20 professions [33].

Many institutions work for employment and skills development in the agrifood sector:

- Founded in 2000, the National Agency for the Promotion of Employment and Skills (Agence Nationale de Promotion de l’Emploi et des Compétences, ANAPEC) facilitates access to job opportunities by matching individual skills with labor market requirements. The agency provides intensive training programs to enhance job seekers’ skills, making them more prepared for the requirements of modern jobs. ANAPEC provides career counseling to help individuals identify the best career paths and develop their professional plans. Many testimonials from individuals who have benefited from the agency’s services show important changes in their career paths, highlighting the agency’s effective role in improving individuals’ lives and providing real job opportunities [52].

- Founded in 1999, the Social Development Agency (Agence de Développement Social, ADS) was set up as a public agency with legal status and financial autonomy, and with a mandate to initiate and support programs aimed at sustainably improving the living conditions of the most vulnerable populations, including smallholders. It finances income-generating activities and employment opportunities, such as food processing and local restaurants, and provides financing that covers all stages from production to consumption. ADS, for example, has funded the program «TATMINE», which promotes local production chains for small farmers, including women [53].

4.1.2. Policy Innovations

Constructing sustainable, thriving, and nourishing food systems is impeded by a multitude of plans, strategies, and policies:

- The Plan Maroc Vert, or Green Morocco Plan (PMV), which is one of Morocco’s delineating national strategies for the years 2008–2020, makes a substantial contribution to the development of sustainable agricultural systems. For the period 2008–2020, Pillar I of the PMV sought to develop modern agriculture through the establishment of key value chains and high-value-added investments; Pillar II sought to assist vulnerable actors in reducing rural poverty through the enhancement of their incomes, and it aimed to halve rural poverty by 2020 [54]. The PMV implemented a regional strategy, which aimed to maximize the capabilities of individual regions. In pursuit of this objective, regional agricultural plans were developed in collaboration with local and regional stakeholders. Once endorsed by the relevant Ministry, these plans would serve as the primary policy documents [55]. It fostered food self-sufficiency in Morocco
to the extent that all vegetables, livestock, and milk are produced domestically, in addition to approximately 70% of the local cereal market. Agricultural value was added, and agricultural exports increased twofold between 2007 and 2018. The PMV facilitated the creation of over 250,000 agricultural sector jobs. The implementation of interventions, including agricultural insurance, irrigation, and water management, benefited over 2.7 million individuals. Each USD 1 of publicly funded incentives generated USD 2.3 of private investment [56].

- The Green Generation Strategy (GG), which is aligned with the 2030 Agenda, spans the years 2020 to 2030. Building upon the achievements of the PMV, the GG provides a contemporary instrument for agricultural development, a fresh perspective on the sector, and a framework for recovering from the COVID-19 pandemic and bolstering the resilience of rural regions. Human capital development and sustainable agricultural development comprise its two pillars, respectively [57]. Pillar I promotes the formation of a new generation of youthful entrepreneurs and an agricultural middle class comprised of 10,000 families. By bolstering the performance of the agricultural value chain, doubling agricultural exports and gross domestic product (GDP) by 2030, and modernizing wholesale markets to ensure more efficient merchandise dispersal, the second Pillar will guarantee the long-term viability of agricultural progress and seeks to stimulate the annual revenue of production chains and ecotourism, replant 13,000 ha of forest, and generate an additional 2750 direct employment jobs. A multitude of facets of food security are influenced by the two pillars when joined. By establishing forest nurseries, an educational and research institution, a water and forest agency, and a nature conservation agency, the GG intends to inspire and engage local communities in forest management activities. Profiting from the comparative advantages of each region, it is implemented using a regional strategy [58].

- Halieutis Plan (Plan Halieutis), which was introduced in 2009 as a supplement to the PMV’s emphasis on agricultural and cattle farming, seeks to improve the sector’s competitiveness in the global economy, preserve of marine biomes and the fishing sector, as well as increase quality and productivity. It aimed to increase the sector’s contribution to gross domestic product and exports, as well as enhance food and nutrition security, all while ensuring the water resources’ long-term viability. Three processing zones were established in Tangier (northern Morocco), Agadir (central Morocco), and Laayoune-Dakhla (southern Morocco) to increase annual domestic fish consumption from 11 kg to 16 kg per capita. The productivity of marine fisheries increased by 7.2% in value by 2017, a 2.3% annual average increase. Presently, 108,000 positions are aboard vessels and 97,000 are on shore in the marine fisheries industry. By elevating fish consumption per capita in Morocco from 11 kg in 2009 to 14 kg in 2017, the associated increased production enhanced the country’s food security and nutrition. Additionally, private investment in the sector amounted to USD 295 million. Fish processing industry investment peaked at 13% [59]. However, a strategy operating under the territorialization approach has been formulated for the period of 2020–2030 [43].

- Initiative Nationale pour le Développement Humain (INDH) translates to the National Human Development Initiative and is a territorial approach to administering agricultural systems, which has been adopted by Morocco to facilitate a more inclusive political process and bring the decision-making process closer to the populace. Initiated in 2005 by the King of Morocco to tackle the underlying factors that contribute to poverty and socioeconomic exclusion, the INDH embodies this novel framework. The INDH endeavors to alleviate poverty through the promotion of collective entrepreneurial thought and networking, as well as the establishment of income-generating activities. Under the INDH, a multi-level governance structure including a strategic committee has been adopted. Under the INDH, agricultural and rural development are top priorities [60]. From 2005 to 2014, over 80% of financed endeavors were concentrated in the farming sector. Youth and women residing in rural regions comprised the majority of
the beneficiaries [61]. In addition, efforts were made to strengthen the actors engaged in the implementation of the INDH and develop their capabilities [55].

- A collaboration among nine ministries resulted in the conception and execution of the National Nutrition Strategy (SNN) for the period 2011–2019 [62]. By ensuring the safety and integrity of food goods, it seeks to enhance nutrition, food accessibility, and affordability. To capitalize on the benefits of regional agricultural products, this strategy involved the implementation of improved cost-control mechanisms, including price support for food, and increased efficiency of small-scale producers. Although the strategy approach was fundamentally central and lacked regional or local dimensions, it did not presume a regional orientation [55].

- The National Integrated Youth Policy (SNIJ), which spans the years 2015 to 2030, endeavors to rectify the inefficacy of disparate sectoral approaches through the implementation of a youth policy that transcends sectors. It ensures that actions for youth in all domains are coordinated by involving sectors including agriculture, environment, education, employment, health, and culture. Particularly for disadvantaged adolescent groups, economic and social inclusion is emphasized. Young people should reach high-quality educational resources, permanent employment opportunities, and adequate health facilities; they should also be able to actively participate in the sociopolitical and cultural sphere, and their basic rights should be respected. The SNIJ was designed to ensure greater youth participation in the formulation of public policies [63].

4.1.3. Programmatic Approaches

To attain the objectives of its various policies, plans, and initiatives, Morocco has implemented several novel programs.

Three stages comprise the INDH’s implementation:

- Stage 1 (2005–2010) was organized around four programs that focused on combating rural poverty, urban social exclusion, and volatility, and an intervention that spans human development.

- Stage 2 (2011–2015) gave a strong impetus to the INDH insofar as the financial envelope allocated to it was increased. Aiming for one million receivers in 3300 rural communities encompassing 22 isolated mountainous areas, this phase of the initiative focused on rural communes and urban neighborhoods.

- Stage 3 (2019–2023) solidified the accomplishments documented in the preceding phases. It is founded upon four programs that prioritize the provision of fundamental services and infrastructure in underdeveloped regions, assistance to those in precarious circumstances, enhancement of youth income and economic integration, and investment in human capital to foster human development for the benefit of future generations [64].

By 2014, the INDH had facilitated the implementation of over 7400 initiatives in the agricultural sector. This includes 3063 livestock-related projects with 45,945 beneficiaries, 300 local product promotion projects with 7407 beneficiaries, 288 fishery-related projects with 4320 beneficiaries, and over 723 small farmer-focused activities with a total of 10,845 beneficiaries [55].

The PMV was executed using inventive interventions that enabled the fulfillment of the aims of the strategy. To establish the agricultural value chain, program contracts and aggregation initiatives were utilized to implement Pillar I. Government institutions, including the Agriculture and Fisheries Ministry, and interprofessional establishments associated with agricultural supply chains jointly affixed their signatures to program contracts. The contracts delineate the obligations of each participating entity to enhance the structure, output, and efficiency of a specified value chain, encompassing both agricultural and processing activities, within a timeframe of seven to ten years. The government incentivizes private sector investment in business through the contract program, contingent upon the value chain and activities involved. Project aggregation revolves around the
principal participants within agricultural supply chains. For instance, industrial-private agri-contracts subsidize the produce of small producers before purchasing it [65].

The support extended to producers includes financial investments, input provision, technical guidance, and financing to enhance agricultural product processing. A premium is paid per production unit in addition to 10% of the aggregation project cost being financed by the government. A project was established in 2013 in the Doukkala-Abda region of central Morocco, centered on the Nestlé Morocco facility. This initiative involved the aggregation of 10,766 dairy farmers, who accounted for 24% of the region’s producers. Organized into 130 milk collection cooperatives, the breeders possessed a total of 17,700 cows. The company aims to increase its annual milk production from the initial target of 40 million liters in 2013 to a total of 74 million liters as a result of this endeavor [66].

Government funding was utilized in the second pillar of the PMV as the primary mechanism to enable small-scale farmers to allocate funds towards activities such as intensification, conversion to commodities with greater value-added, and diversification through increasing the value of local products to generate supplementary revenues [65]. The FDA, for example, has implemented numerous government-sponsored incentives to encourage the purchase of agricultural equipment. Depending on the type of equipment, between 30% and 70% of the cost of agricultural machinery was subsidized [67]. ONCA additionally furnished agricultural guidance and instruction to producers as part of intensification programs. As of 2011, the ADA had approved over 325 initiatives, representing a cumulative public investment of USD 1.13 billion. The remaining two-thirds of the initiatives [65] were fruits and vegetables. Annually, around 12 million trees were transplanted onto an area of 1 million ha of land unsuitable for cereal crops [19].

In addition, Morocco prioritized the development of irrigation to create a more resilient and productive agricultural system and to reduce the susceptibility of small producers to climate disturbances. Initiated in 2008, the irrigation expansion program aims to cover 160,000 ha by 2020 with the modernization of 1.5 billion m$^3$ of water through hydroagricultural developments [68]. Simultaneously, the Moroccan government executed the National Program for the Conservation of Irrigation Water (PNEEI), Scientific Program National al d’Economie d’Eau en Irrigation, to increase water-use efficacy in irrigation for sustainable purposes, from 2008 to 2020. The objective of the PNEEI is to modernize and enhance conventional and group irrigation systems to increase the adoption of drip irrigation. To support this program, the FDA provided financial assistance to producers for the purchase of equipment. Furthermore, by participating in the collection systems and cultivating high-value crops, the farmers were able to increase their return on water investment with the assistance of counsel and direction. During the period from 2008 to 2014, the land area irrigated with drip systems increased to 450,000 ha [69] due to these efforts. Offering private investors long-term land leases in exchange for their participation in the development of new irrigation projects [68] reflected a significant emphasis on public–private partnerships (PPPs). PPPs in irrigation reduce the financial burden associated with public-sector investment subsidies. A 30-year contract was entered into by the Ministry and a private firm in 2015 for the construction, operation, and co-financing of desalination and irrigation infrastructure spanning an area of 13,600 ha in the Chtouka plain [70]. For example, precipitation was 50% below average during the 2015/2016 agricultural season; nevertheless, agricultural GDP fell by only 7%, providing concrete evidence that the irrigation scheme has bolstered farmers’ perseverance and protected them from weather fluctuations. GDP contraction could have reached 40% before the expansion of irrigation [71].

Furthermore, to promote employment, the Moroccan government has enacted numerous initiatives, several of which are focused on the agricultural sector. To promote employment in rural areas, the Ministry of Labor and Professional Integration (Ministère du Travail et de l’Insertion Professionnelle, MTIB), ANAPEC, and the German International Cooperation Agency (GIZ) have developed an integrated strategy. This strategy incorporates activities such as identifying local employment sector requirements, local
deliberations, and the extension of an employment instruction and direction center network to assist youth in their job-seeking. Youth participate in brief training programs tailored to rural environments [72]. To increase the sustainability of the paradigm, the initiative assists important actors engaged in national and regional employment promotion. More than 2500 young men and women aged 15 to 35 benefited from the initiative during the first phase, which ran from 2015 to 2017. Of the supported youth, 47% obtained employment or saw an increase in income. The secondary stage of the initiative dedicates the years 2018 to 2021 to implementing the intervention in alternative provinces to expand its reach to an additional 3000 young individuals [73].

4.2. Challenges of Sustainable Food Systems

At present, Morocco is confronted with the consequences of prolonged unsustainable resource utilization and the adverse environmental impacts of climate change, including but not limited to disturbed precipitation patterns, prolonged droughts, soil degradation, desertification, and pollution [74–76]. Governmental programs are compelled to simultaneously consider multiple production systems while attempting to preserve the sustainability of the system [77,78]. As a result, addressing sustainability challenges has become more difficult. Infrastructure and human capital are still insufficient for organic cultivation to achieve success [79]. Furthermore, the substantial surge in greenhouse gas emissions that Morocco has experienced in recent decades can be attributed to its economic expansion, of which agriculture is responsible for 21% [80]. With an annual cereal intake of 200 kg/capita, the Moroccan diet accounts for 60% of the country’s dietary energy supply [81], and is an additional pressure point on the agri-food system. Cereal production is extremely dependent on precipitation, which makes self-sufficiency difficult to achieve. Morocco is therefore compelled to import cereals, amounting to 40% of its domestic requirements [82]. Global grain supply chains have been disrupted by the Russia–Ukraine war, raising the threat of food insecurity in Africa. Countries that import agricultural inputs such as fertilizers have to prepare for possible supply-chain disruptions, and food prices could rise if the war disrupts the production of staples such as wheat [83]. On the other hand, there is not a clear strategy for food losses and waste management, not to mention the lack of studies with precise statistics on the extent of the phenomenon. Landfills suffer from rapid filling and municipalities refuse to install new ones in their territories. Besides, the high recovery cost poses a sorting problem, given that certain municipalities lack financial resources. A major problem exists also in the control and follow-up of delegated management contracts [84]. In addition, the COVID-19 pandemic influenced agri-food systems worldwide [85].

4.3. Opportunities

By enhancing the agri-food sector’s efficiency, inclusivity, and environmental sustainability, digital technologies may provide a remedy for food system improvement in Morocco [86]. As a result, producers, consumers, and society as a whole can experience greater benefits [80]. Increased on-farm productivity, enhanced resource utilization efficiency, and climate resilience can be facilitated by these technologies [87]. Moreover, they can contribute to a substantial reduction in food losses and waste, as well as notable improvements in the core areas of manufacturing, logistics, and supply-chain management. Particularly in the agri-food industry, COVID-19 has increased awareness of the necessity and utility of adopting digital technologies [88]. Additionally, the opportunity to ensure food security is presented by Morocco’s climate, biogeographical, and cultural diversity, which results in a wide range of cultivars, animal strains, and indigenous production knowledge. In addition, Moroccan producers have demonstrated in the past a strong capacity to manage local agriculture both individually and collectively. Morocco possesses substantial expertise in irrigation water management and is currently progressing towards the adoption of localized irrigation systems. By enhancing the efficacy of irrigation systems and the sustainability of irrigation schemes, public–private partnerships in irrigation are an effective instrument for enhancing the performance of agricultural irrigation in terms...
of water resources development. A substantial portion of agricultural production is also guided by scientific and agronomic research with a focus on sustainability [61].

4.4. Outcomes

Morocco has achieved notable success in its export production growth and poverty reduction to below 5% of the population through its agricultural planning efforts over the last two decades [89], particularly the latter decade. In Morocco, the proportion of wasted and malnourished children declined from 25 to 15% and from 4 to 3%, respectively, and the country’s Global Hunger Index score decreased by 43% between 2000 and 2020 [90], with a score of 9.0 in the 2023 GHI (Figure 1) according to recent statistics, and a rank of 47th out of 125 countries [91]. Morocco has demonstrated notable progress in the reduction of poverty and famine [92]. If we include significant groups that lack access to fundamental social services and adequate shelter, however, food insecurity affects millions more individuals. It has been determined that North Africa has entered a food security crisis [90]. Specifically, food inflation has reached unprecedented levels in Morocco, Tunisia, and Algeria since the Arab Spring civil unrest a decade ago. Furthermore, Morocco has experienced a three-year average of 28% moderate-to-severe food insecurity rate from 2018 to 2020.

![Figure 1. Morocco’s GHI 2023 indicated on GHI severity scale. (Source: GHI, 2023).](image)

5. Conclusions

If food systems fail, dire consequences are expected, jeopardizing humans and the planet. Therefore, food security and the transition to sustainable food systems are subjects of discussion today. However, to our knowledge, there is a lack of scientific literature reviews about the transformation of Morocco’s food systems towards sustainability. This work aims to compile—in one review paper—information about food system transformation towards sustainability in the world, focusing on Morocco’s key drivers, interventions, achievements, challenges, opportunities, and outcomes. Globally, many food systems are already undergoing major transformations aiming for sustainability. Our paper showed that Morocco’s drivers (climate change, globalization, income growth and socio-economic development, urbanization, population growth, policies, and socio-cultural traditions) for food system transformation are not different from those of the world. Morocco, in turn, is furnishing remarkable efforts in this regard, despite the existing challenges; the inability to effectively address the detrimental effects of climate change and escalating water scarcity was identified as the fundamental cause of this vulnerability. Additionally, COVID-19 has added pressure on African food systems. A meaningful sustainability transition is guided and carried out at the institutional, policy, and programmatic levels, resulting in many achievements. However, there are conflicting views on the outcomes of food system transformation. Some studies showed that Morocco has achieved notable successes in increasing export production and reducing poverty to less than 5% of the population, particularly over the past decade; the proportion of wasted and malnourished children has declined from 25 to 15% and 4 to 3%, respectively, in this country. The 2023 GHIs showed a score of 9.0, which suggests that Hunger is low in Morocco. Other studies showed that North Africa has entered a food security crisis. Specifically, food inflation has reached unprecedented levels in Morocco, Tunisia, and Algeria since the Arab Spring civil unrest a decade ago. It was argued that, despite the positive results achieved by food system developments over the last three decades, the associated rapid structural transformations have increased challenges with potentially wide-reaching consequences regarding the
condition of nutrition and food security. So, it is time to redouble efforts to overcome
the challenges of developing food systems towards sustainability, both in Morocco and
globally. This paper provides precious insights, enabling policy makers and planners to
design evidence-based policies and strategies and contribute to the advancement of current
knowledge in this field, not only eliminating hunger and malnutrition, but also stimulating
sustainable development in Morocco.

**Funding:** This research received no external funding.

**Conflicts of Interest:** The authors declare no conflicts of interest.

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