CHAPTER 18

Aligning Food Security with SDGs and Climate Commitments

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Abstract

The food security of developing economies is at a crossroads. Millions of people still experience hunger and malnutrition even though agricultural production is aggravated by climate change. The increasing temperatures, erratic rainfall, droughts, and floods endanger crop yields, soil quality, and livelihoods. In the meantime, agriculture is also a significant source of greenhouse gases, and food systems are both victims and contributors to climate change in a complex cycle. These two problems require radical, composite, and future-looking policies. This chapter addresses the multidimensional nature of food security through the four pillars of food security: availability, access, utilization, stability, and socioeconomic and institutional environments that lead to results in the developing world. It emphasizes the importance of international mechanisms, such as the Sustainable Development Goals and the Paris Agreement, in finding the right balance between national policies, climate obligations, and development priorities. This correspondence is reflected in the creation of new strategies. As ways to create resilient, productive, and low-carbon food systems, climate-smart agriculture, agroforestry, sustainable land and water management, biodiversity conservation, and food loss and waste reduction are discussed. The potential of scientific and technological innovations, such as precision farming or crop varieties that are resistant to unfavorable climate conditions and digital solutions, has never been as high as it is now, to transform agricultural activities. This is also essential in the face of inclusive and sustainable socioeconomic and institutional interventions such as policy integration, capacity building among farmers, gender equity and value chains. The chapter combines climate adaptation, mitigation, and food security to give a roadmap on how the developing economies can develop resilient and equitable food systems. It focuses on evidence-based, practical policy solutions and strategies that will assist in maximizing the synergies, reducing trade-offs, and empowering communities. Harmonizing food security and climate action has thus become an imperative rather than an option, requiring coherent, cross-sectoral policies that safeguard food availability, livelihoods, and environmental sustainability for present and future generations.

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1. Introduction

Food security has been one of the most pressing concerns in developing economies, where rapid population growth, resource shortages, and socioeconomic disparities have posed challenges for food systems. To this day, a large portion of the world's population lacks stable access to adequate, safe, and nutritious food, even though agricultural productivity has significantly increased over the last several decades (Ogwu *et al*., 2024). Another cause of this issue is climate change, which shifts temperature regimes, intensifies extreme weather events, and alters agricultural production patterns. Therefore, sustainable food security is no longer just an agricultural issue but a multidimensional policy issue that traverses the environmental sustainability and global development agendas (Battersby, 2018).

The integration and inclusive development planning took a major step when the United Nations adopted the Sustainable Development Goals. Specifically, SDG 2 (Zero hunger) and SDG 13 (Climate Action) emphasize the immediate need to address food insecurity and combat climate change (Atukunda *et al*., 2021). Along with this, the Paris Agreement has strengthened international commitment to reducing greenhouse gas emissions and increasing adaptive capacity, which have direct effects on agricultural systems and food production. Nevertheless, most developing nations have policy frameworks that address food security and climate change issues in isolation from one another, with little chance of realizing synergies (Leahy *et al*., 2020).

It is an urgent and strategic need to align the food security policies with the Sustainable Development Goals and climate commitments. This kind of alignment can benefit governments through co-benefits, such as increased agricultural resilience, carbon sequestration, and sustainable resource management (Cohen *et al*., 2021). Climate-smart agriculture, agroforestry, and nature-based solutions are approaches that can combine productivity, adaptation, and mitigation targets. However, this alignment will take place only after institutional fragmentation is overcome by enhancing the effectiveness of governance institutions and ensuring adequate financing and technology are in place (Shebanina *et al*., 2024).

This chapter examines the interfaces between food security, the Sustainable Development Goals, and climate commitments, with specific attention to developing economies. It employs an analytical framework that traces how climate change affects the four pillars of food security (availability, access, utilization, and stability), how SDG implementation shapes food system outcomes, and how mitigation and adaptation interact, including potential synergies and trade-offs. It examines the conceptual interconnections, enumerates the major policy issues, and identifies ways to promote coherence between sectors. The chapter seeks to strengthen and sustain a food system that can support current and future needs in the face of variable climatic changes.

1.1. Concepts, Dimensions, and Determinants of Food Security: Understanding Food Security

Food security is a multidimensional phenomenon that has transformed over the years to encompass availability, access, utilization, and stability of food. The Food and Agriculture Organization defines food security as a situation in which everyone, at all times, has physical, social, and economic access to adequate, safe, and nutritious food that meets their dietary needs and preferences, enabling them to live an active and healthy life. This definition emphasizes the importance of the quantity and quality of food, as well as socioeconomic factors influencing access. In developing countries, food security is also closely linked to poverty reduction, agricultural development, and resilience to environmental and economic crises (Shakeel, 2018).

Table 18.1: Four Pillars of Food Security

Pillar	Key Determinants	Global Indicators/Facts
Availability	Agricultural productivity, land use, trade policies and food aid	**828 million:** Estimated number of people facing hunger globally due to supply disruptions and climate shocks
Access	Household income, market proximity, food prices and infrastructure	**High-Price Volatility:** In developing nations, households may spend over 50-70% of their income on food.
Utilization	Clean water access, sanitation, nutrition education, and healthcare	**Stunting:** Affects roughly 22% of children under 5 globally due to poor nutrient uptake and sanitation.
Stability	Climate resilience, political stability, and income steady states	**Climate Impact:** Extreme weather events have increased by 400% since the 1980s, threatening long-term food stability.

1.2. Determinants of Food Security

Food security in developing economies is a complicated interaction of environmental, economic and socio-political elements. The key factors include the productivity of agriculture, availability of land and water, climate as well as technological advancements. Specifically, climate change is a critical menace to crop production, water availability, and the occurrence of extreme events. (Onyenekwe *et al*., 2022).

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The availability of food directly relates to economic characteristics such as income distribution, labor availability, and food prices, and to governance, policy frameworks, and institutional capacity that define the success of food security interventions. Social factors, including education, gender equality, and cultural practices, are also significant in shaping food use and nutritional outcomes (Nhamo *et al*., 2022).

These determinants need to be addressed in a holistic manner in order to come up with policies that do not only amplify food production but also balance access and sustainability with the growing environmental and socioeconomic demands.

2. Climate Change and Food Systems: The effects, emissions, and vulnerability of developing economies

The global food system is slowly changing due to climate change, and some of the worst impacts have been felt in developing economies, where agriculture is extremely climate-sensitive. The rising temperatures altered rainfall patterns, and the increasing frequency and intensity of extreme weather events such as droughts, floods, and heatwaves are disrupting agricultural production (Narayan *et al*., 2024). Besides reducing crop production, these climatic stresses alter crop quality, soil fertility, and water availability, thereby undermining the overall resilience of farm systems. In rain-fed agricultural areas that make up a major part of the developing world, even slight changes in climate can drastically affect food production and rural livelihoods. In addition, climate shocks disrupt supply chains, cause unstable prices, and lead to food insecurity. Consequently, agricultural systems must be shifted towards more adaptive and resilient systems to maintain food security in changing environmental conditions (Jha & Dev, 2024).

Food systems and climate change are in a complex, reciprocal relationship, despite their vulnerability, as agriculture is also a significant source of greenhouse gas emissions. Enteric fermentation in livestock and rice production, nitrous oxide (N_2O) caused by the excessive use of nitrogen-based fertilizers, and carbon dioxide (CO_2) due to land-use changes, especially deforestation and land degradation, are the major sources of methane, nitrous oxide, and carbon dioxide, respectively (Küfeoğlu, 2024). The percentage of global emissions attributed to agriculture, forestry, and other land use (AFOLU) has been high, as per the Intergovernmental Panel on Climate Change. The causes of carbon footprint of the sector also include some unsustainable farming practices such as overuse of chemical inputs, monocropping, and poor land stewardship. To overcome these problems, sustainable land management, nutrient-use efficiency, and carbon sequestration (e.g., agroforestry and conservation agriculture) policies need to be enforced (Loboguerrero *et al*., 2019).

The developing countries are structurally vulnerable to climate change. More prone to use agriculture as a source of income and economic stability, but less diversified because of the lack of funds, inefficient infrastructure, and access to technology, these countries are also less versatile. The smallholder farmers who form the agricultural production backbone of most developing areas are especially prone. Inadequate access to credit, extension facilities, varieties that are resistant to climate, and irrigation systems diminish their ability to respond to climatic shocks and adapt to a changing environment. In addition, weak performance of response is attributed to dysfunctional institutional structures, lack of cohesion in policies, and lack of funding in agricultural research and climate change adaptation. Poverty, inequality and lack of education are socioeconomic issues that compound vulnerability and the communities that suffer environmental shocks have a hard time recovering. (Thakur *et al*., 2024).

Technological, institutional, and socioeconomic interventions should be part of the process of developing resilience in developing economies. Adaptive capacity can be greatly improved through climate-smart agriculture, improved access to climate information services, capacity building, and financial tools, such as climate funds and insurance tools. This will require reinforcement of governance, enhanced policy coherence, and inclusion of vulnerable populations in development strategies. Governance quality, institutional effectiveness, and political incentives are critical determinants of whether technical and environmental solutions translate into sustained food security outcomes; without addressing these political economy dimensions, even well-designed interventions risk limited uptake and poor long-term impact. Finally, it is important to address the coupled problem of climate change and food systems to achieve

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sustainable food security and sustainable development amid growing environmental uncertainty (Silici *et al.*, 2021).

3. Food Security: SDG Framework Interlinkages, Synergies, and Trade-offs

3.1. SDG 2 – Zero Hunger

Goal 2 of the Sustainable Development Goals, Zero Hunger, is one of the pillars of the global development agenda, focusing on eliminating hunger, achieving food security, and enhancing nutrition and sustainable agriculture by 2030. It is a holistic reflection of the fact that food security goes beyond simple increases in food production to encompass equitable access, nutritional quality, and the long-term sustainability of food systems. Here, SDG 2 focuses on the quantity of food produced, its accessibility and affordability, and its capacity to meet the dietary needs of different populations (Atukunda *et al*., 2021).

One of the challenges addressed by SDG 2 is the elimination of all forms of malnutrition, including undernourishment, micronutrient deficiencies, and the rising rates of diet-related non-communicable diseases. This underscores the significance of diversified food, better food use, and better health interventions for the population. Moreover, the goal highlights the importance of increasing the agricultural productivity and incomes of small-scale food producers, especially smallholder farmers, women, and indigenous peoples, who are crucial to food production in the developing world. Improving livelihoods and achieving inclusive growth requires improving their access to land, inputs, financial services, markets, and technology (Hiywotu, 2025).

The second important aspect of SDG 2 is the encouragement of sustainable and resilient agricultural development. Climate change poses a significant threat to food production systems, and there is therefore an urgent need to adopt strategies that increase adaptive capacity and minimize environmental impacts. The SDG 2 sustainable agriculture practices involve the efficient use of resources, the protection of soil and biodiversity, and the minimization of chemical inputs. Such measures will not only result in productivity in the long run but also protect natural resources (Lile *et al*., 2023).

SDG 2 has been a major challenge in developing countries due to high population growth, poverty, insufficient infrastructure, and vulnerability to climate change. The issue of food insecurity is a major concern for the population, particularly in rural areas where agriculture is a key income-generating activity. The situation is exacerbated by conflicts, economic uncertainties, and market upheavals. Therefore, SDG 2 is possible with local, national, and global activities, which are integrated and coordinated. It is important to improve policy frameworks, invest in agricultural research and innovation, develop rural infrastructure, and reinforce the social protection system. By addressing the underlying causes of hunger and ensuring environmental sustainability and resilience, SDG 2 can assist developing economies in attaining food security and improved nutrition through sustainable food systems (Atukunda *et al*., 2021; Hiywotu, 2025).

3.2. Linkages with SDG 1, 3, 6, 12, 13, and 15

As a concept, food security is cross-cutting, as it is closely associated with many of the Sustainable Development Goals. These interlinkages highlight that food security is not an objective in itself but must be built on a broad continuum of socioeconomic and environmental dimensions.

SDG 1 (No Poverty) stands out especially, and poverty is a significant barrier to food access. Poverty is a major impediment to food security because poor households can hardly afford proper, healthy food. Speaking of which, SDG 3 (Good Health and Well-being) closely connects to nutrition, as malnutrition and micronutrient deficiencies, as well as an increased number of diet-related diseases, are outcomes of poor diets (Feliciano, 2019).

SDG 6 (Clean Water and Sanitation) is crucial to food production and consumption. Water is important for irrigation, livestock, and food processing, and for preparing food safely and utilizing nutrients properly; access to clean water and sanitation is needed. The unavailability of adequate water resources and sanitation systems leads to poor agricultural productivity and poor human health (Küfeoğlu, 2022).

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In addition, SDG 12 (Responsible Consumption and Production) aims to minimize food loss and waste and improve the efficiency of natural resources throughout the food supply chain. It is particularly so in the developing world, where even after the harvest, post-harvest losses consume the food supply. SDG 13 (Climate Action) relates to both the direct and indirect impacts of climate change on food systems, including crop production, water supply, and the occurrence of extreme events (Campbell *et al*., 2018).

Additionally, SDG 15 (Life on Land) emphasizes protecting terrestrial ecosystems, forests, and biodiversity because they play a crucial role in sustaining agricultural productivity and ecosystem services, such as pollination and soil fertility (Wang *et al*., 2020).

These interrelations have shown that integrated, coordinated policy responses are necessary to achieve food security. By addressing these linkages, one can generate synergies, enabling numerous development objectives to be achieved simultaneously and ensuring long-term development sustainability.

3.3. SDGs Synergies and Trade-offs

Interrelations among the SDGs can create synergies but may also introduce trade-offs. For example, sustainable agriculture can improve food production, mitigate climate change, and protect biodiversity. Agroforestry and climate-smart agriculture are among the approaches that can help achieve the SDGs 2, 13, and 15.

Some of the policies aimed at increasing food production, however, have side effects, including deforestation, water depletion, and greenhouse gas emissions. Key trade-offs that policymakers must navigate include: agricultural intensification versus biodiversity conservation; irrigation expansion versus long-term water sustainability; biofuel production versus food availability; and emission reduction targets versus productivity objectives for smallholder farmers. Likewise, the need to increase farmlands can be counterproductive to the aim of preserving the ecosystems. Therefore, such trade-offs must be carefully managed by policymakers through evidence-based planning and integrated systems (Figure 18.1). Coherence across sectors needs to be fostered, and national strategies need to be aligned with global goals to achieve maximum synergies and sustainability in food security and environmental protection. (Xiao *et al*., 2023).

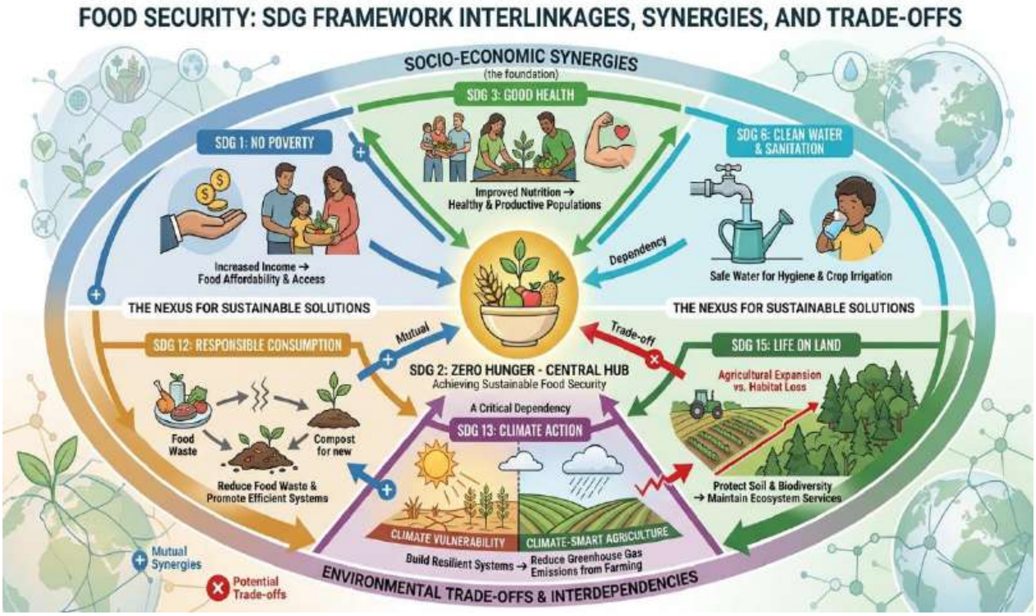

Figure 18.1: Theoretical Model

This theoretical model portrays SDG 2 (Zero hunger) as the center, with the necessary synergies of environmental and socioeconomic stability. It highlights the balancing act required to balance global food security with trade-offs in climate action and land conservation.

4. Global Climate Commitments and Policy Frameworks

Climate change is one of the greatest threats to food security, agricultural productivity, and sustainable development worldwide. Global warming, experienced worldwide due to increased temperatures, altered precipitation patterns, and extreme weather conditions, is interfering with agricultural production systems. They are especially dramatic in the developing world, where agriculture is the livelihood of the rural population and the mainstay of the national economies (IPCC, 2022; FAO, 2023). Climate change affects crop productivity, soil fertility, water availability, and pest dynamics, posing significant risks to food production and food supply chains (Schmidhuber and Tubiello, 2007; Wheeler and Von Braun, 2013). However, food systems and agriculture are also major sources of worldwide greenhouse gas (GHG) emissions. The agriculture, forestry, and other land use sectors also contributes about 21-24 percent of anthropogenic GHG emissions around the world, such as the emission of methane because of livestock and rice cultivation, nitrous oxide because of fertilized soils, and carbon dioxide because of land-use change (IPCC, 2022; Crippa *et al*., 2021; OECD, 2024). Attributing the entire food system (processing, transport, and consumption) to emissions may account for up to 1/3 of global emissions (Mukherji *et al*., 2024). The dual nature of agriculture as both a cause and a consequence of climate change has contributed to the growing acceptance of the need to integrate climate mitigation and adaptation policies with food security policies. International climate governance systems are significant for informing national and international efforts to address these problems. The main international policy instruments include the Paris Agreement, Nationally Determined Contributions, the Koronivia Joint Work on Agriculture, and national adaptation and mitigation plans, all under the United Nations Framework Convention on Climate Change (UNFCCC). These frameworks present a policy framework to align climate commitments with the Sustainable Development Goals, particularly Zero Hunger (SDG-2) and Climate Action (SDG-13).

4.1. Paris Agreement

The Paris Agreement is a historic global accord adopted in 2015 to combat climate change by aligning mitigation and adaptation efforts. The agreement stipulates the long-term aim of cutting global warming to well below 2 o C above pre-industrial levels, and targets 1.5 o C. This would be achieved through large reductions in GHG emissions at the international level and by increasing adaptive capacity in vulnerable sectors, including agriculture, water resources, and ecosystems. One of the few unique aspects of the Paris Agreement is its recognition of the strong link between climate change and food security. The necessity of protecting food production systems and responding to climate change is explicitly emphasized in the agreement, stating that mitigation and adaptation policies must not undermine agricultural productivity. It is a pointer to the increasing panic that climate change will lead to significant upheaval in the global food supply systems (Rogelj *et al*., 2016; IPCC, 2023).

Climate change can affect agricultural production in various ways. The increase in temperature can lower crop yield by increasing plant respiration rates and shortening crop development time (Rezaei *et al*., 2023). Alterations in rainfall patterns may lead to prolonged droughts or excessive flooding, threatening agricultural productivity and soil quality. Also, climate change may increase pest, weed, and disease populations, further undermining food production systems (Wheeler and Von Braun, 2013; IPCC, 2022). In this scenario, the Paris Agreement promotes the uptake of climate-smart agriculture (CSA) practices that can improve agricultural productivity, resilience to climate variability, and GHG emissions reduction (Lipper *et al*., 2014; FAO, 2023). Some of the CSA practices are conservation agriculture, better irrigation practices, integrated nutrient management, agroforestry, and sustainable livestock production. Agroforestry systems can greatly increase carbon sequestration while raising soil fertility, biodiversity, and farm productivity. Recent research has shown that the agroforestry systems have the potential to sequester 0.5-5 Mg of carbon per hectare per year, in addition to offering economic gains and stabilizing farm incomes (Abbas *et al*., 2026). Moreover, the Paris Agreement facilitates global collaboration through climate finance schemes, including the Green

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Climate Fund, as well as technology transfer and capacity-building programs that help vulnerable countries develop climate-resilient agriculture (Buchner *et al*., 2013; FAO, 2023).

4.2. Nationally Determined Contributions (NDCs).

One of the key mechanisms for implementing the Paris Agreement is the Nationally Determined Contributions (NDCs) system. These national climate action plans describe each country's commitments to reducing GHG emissions and adapting to the effects of climate change. In contrast to previous international treaties, NDCs allow countries to set their own climate goals based on national priorities, economic factors, and technological possibilities (UNFCCC, 2021). NDCs have been broadly inclusive of agriculture and food systems due to their susceptibility to climate change and their national economic and food security significance. According to recent studies, over 90 percent of developing nations also have agriculture as a priority sector in their climate adaptation NDCs (FAO, 2023). Typical farm adaptation measures described in NDCs are:

- Production of climate-resistant plant types.
- Better irrigation and water management system.
- Land restoration and soil conservation programs.
- Integrated pest management.
- Early warning systems and climate information.

These actions are meant to strengthen agricultural systems to climate variability without reducing food production. In addition to adaptation policies, most NDCs include mitigation policies to reduce agricultural emissions. The significant contributors to agricultural emissions are methane from livestock and rice production, and nitrous oxide from fertilizer use (Crippa *et al*., 2021; IPCC, 2022). These emissions can be greatly minimized through better manure management and application, precision fertilization, and sustainable livestock feeding practices without reducing productivity (Smith *et al*., 2020; OECD, 2024). Although agriculture has been increasingly included in NDCs, implementation has been a challenge. The majority of developing countries are financially constrained and have limited institutional capacity, and they cannot access climate technologies. To transform NDC commitments into agricultural climate action, therefore, there is a need to improve global collaboration, climate financing, and capacity-building efforts (Buchner *et al*., 2013; FAO, 2023).

4.3. Nationally Adaptation and Mitigation Strategies

Global climate objectives established by international agreements are implemented by national governments through national adaptation and mitigation strategies. Many countries have developed National Adaptation Plans (NAPs) and sectoral climate policies in reaction to the vulnerability of agricultural systems to the effects of climate change. The national adaptation plans also aim to increase the resilience of agricultural systems through better water management, the development of climate-resistant crop varieties, diversification of agricultural systems, and the rehabilitation of degraded lands. The measures enable farmers to manage climate variability and ensure stable food production (IPCC, 2022; FAO, 2023).

The mitigation measures aim to reduce greenhouse gas emissions in the agricultural sector. Conservation agriculture, agroforestry, better grazing management, and the restoration of degraded ecosystems are among the major strategies. These plans help minimize emissions and improve ecosystem services such as soil fertility, water retention, and biodiversity conservation (Smith *et al*., 2020; Lee and Ignaciuk, 2025). The idea of food system transformation is gaining increasing importance in recent policy debates, as it addresses the effects of climate change across the entire food supply chain, including production and consumption. Food systems can also significantly influence the environment by minimizing environmental footprints through reduced food loss and waste, improving supply chain efficiency, and promoting sustainable diets (Willett *et al*., 2019; FAO, 2023). Food waste alone accounts for about 8% of global GHG emissions, underscoring the significance of systemic strategies to reduce GHG emissions in food systems (UNFCCC, 2021). National climate strategies should be properly coordinated at the institutional level with the sectors involved in the process, such as agriculture, forestry, water resources, and rural development. The policies

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on climate and food security should be combined so that mitigation actions do not impact food production, and adaptation work is made more resilient for agriculture (Figure 18.2).

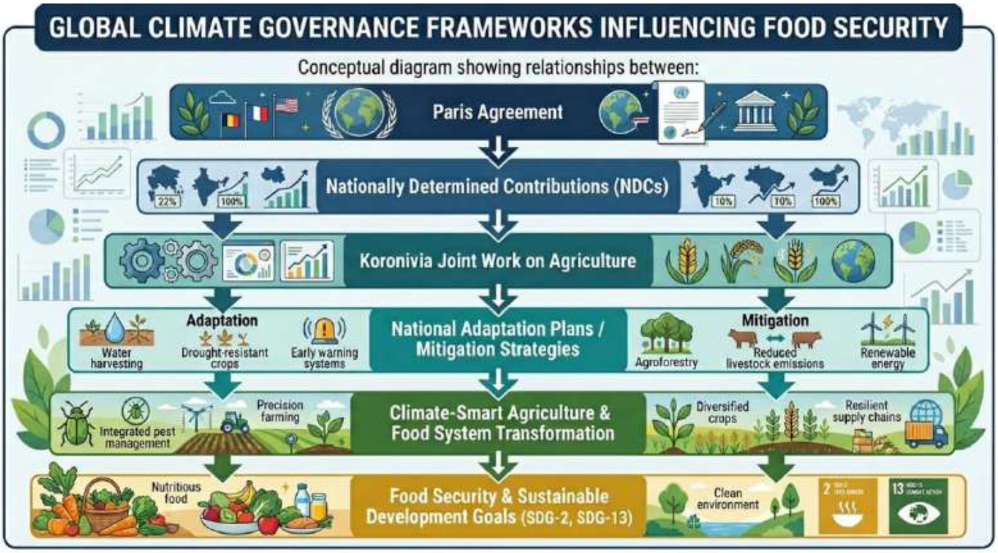

Figure 18.2: Global Climate Governance

4.4. Aligning Food Security with Climate Action Strategies

Food security should be aligned with climate action in an integrated, holistic manner that covers agricultural productivity, environmental sustainability, and climate risk resilience. In developing economies, where food systems are highly susceptible to climatic variability, strategic interventions should aim at adaptation and mitigation, with a focus on long-term sustainability (Olarewaju *et al*., 2025).

One framework that has played a significant role in these goals is climate-smart agriculture (CSA). CSA enhances productivity and climate adaptation and mitigation practices, including crop diversification, improved nutrient management, and more efficient resource use. Not only do these practices stabilize yields under changing climatic conditions, but they also reduce greenhouse gas emissions (Matteoli *et al*., 2020).

Land and soil management should also be sustainable, as they are the basis of agricultural productivity. Soil fertility, water retention, and carbon storage can be enhanced through conservation tillage, soil organic amendments, and land restoration practices. The approaches are relevant in reversing the tide of land degradation and rendering agricultural systems sustainable in the long term (Shah & Wu, 2019).

Agroforestry can be a viable option for combining food production and environmental preservation. Planting trees in agroforestry systems can address biodiversity and soil health requirements and achieve considerable carbon sequestration. This is particularly true in developing countries, where these systems provide numerous livelihood and ecological benefits. Water resource management is another crucial aspect, especially in regions with water shortages. Water use can be made efficient through effective irrigation techniques, rainwater harvesting, and integrated watershed management, and agricultural production can be sustained even in the face of changing climatic conditions. (Raj *et al*., 2019).

The resilience of food systems is also enhanced by biodiversity conservation, which helps sustain the ecosystem services necessary for food production, such as pollination, pest control, and nutrient cycling. Conservation and augmentation of biodiversity make agricultural systems more resilient to environmental changes (Figure 18.3).

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Sustainable livestock systems are also crucial for reducing the environmental footprint of farming. The adoption of better feeding programs, livestock breeding systems, and integrated livestock-crop systems can boost productivity and reduce greenhouse gas emissions.

Lastly, minimizing food loss and waste is a cost-effective way to enhance food access and does not place an additional burden on natural resources. Enhancing supply chains, storage infrastructure, and responsible eating can greatly improve the effectiveness of food systems (Singh *et al*., 2025).

Figure 18.3: Food Security and Climate Action Strategies

4.5. Innovation and Technology

The key to changing the food systems and making them climate-oriented is technological progress and innovation. Over the past few years, the advent of digital technologies in agriculture has opened new possibilities to improve productivity, efficiency, and resilience. Precision agriculture allows farmers to make the most of their inputs, including water, fertilizers, and pesticides, with the help of sensors, satellite photos, and data analytics. A more developed method like this can help minimize waste, reduce production costs, and reduce environmental impacts. Digital and smart farming technologies can also help inform decisions by providing real-time information on weather, soil health, and crop performance. Farmers will have access to timely information through remote sensing, climate advisory services, and mobile applications, thereby enhancing risk management and productivity. Emerging applications of artificial intelligence in agriculture, including predictive crop modeling, pest detection, and yield forecasting, alongside blockchain-enabled traceability systems and digital advisory platforms, are increasingly shaping climate-resilient food systems by improving supply chain transparency and smallholder market access. Moreover, better crop varieties should also be introduced, including drought- and climate-resistant varieties, to adapt to the shifting climatic and environmental conditions. Plant breeding and biotechnology have led to higher yields, improved nutrition, and resistance to pests and diseases (Osumba *et al*., 2021; Pimenow *et al*., 2025).

4.6. Opportunities and Future Directions

A combination of food security and climate action will offer developing economies an innovative opportunity to build a resilient and sustainable food system. Economic development and environmental sustainability can be co-opted in order to meet a number of objectives, including more productivity, less pollution, and better living standards. The new generation will have to invest in research and innovation, in particular in technologies and nature-based solutions more resistant to climate change. It will require establishment of

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institutional competence and governance systems to be policy competent and coordinating. Additionally, international cooperation and knowledge exchange can also be significant in solving common problems and following best practices. They will prevent the exclusion of any part of the population by including growth, participatory strategies, and evidence-based policymaking. Lastly, technological innovation, sustainable management of resources and effective institutional support should be put together as one to help achieve food security and climate commitments. This kind of approach will assist developing countries to deal with the complex problems of the 21 st century and be able to provide future generations with food security and environmental sustainability (Figure 18.4).

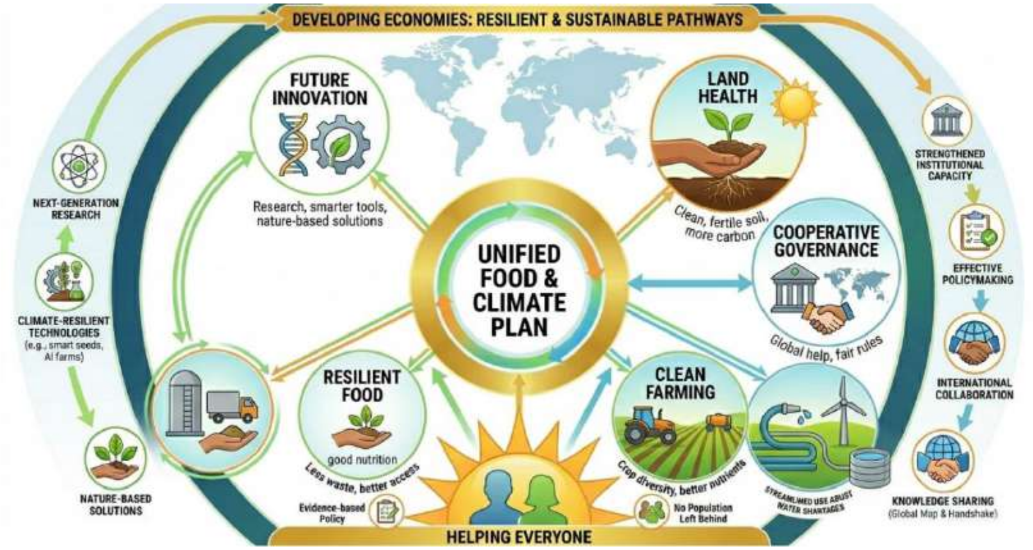

Figure 18.4: Resilient and Sustainable Pathways

5. Policy Recommendations

Attaining food security-climate action alignment will need consistent, integrated, and proactive policy frameworks organized across multiple actors and levels of governance. National governments should ensure policy coherence by integrating NDC commitments into national agricultural plans, providing financial incentives for climate-smart agriculture (CSA) and agroforestry, and enacting gender-inclusive land tenure reforms to secure equitable access for women and marginalized smallholders (expected outcome: reduced policy fragmentation and improved adaptive capacity). International organizations and development partners should scale up climate finance through the Green Climate Fund and blended finance mechanisms, while supporting technology transfer of precision agriculture, remote sensing, and digital advisory services to farmers in developing economies (expected outcome: accelerated adoption of climate-resilient technologies). Agricultural research institutions should prioritize the development of drought-tolerant and heat-resistant crop varieties, generate regionally differentiated evidence on CSA performance across South Asia, Sub-Saharan Africa, Southeast Asia, and Latin America, and strengthen climate information services for smallholders (expected outcome: context-specific, evidence-based interventions). Firstly, policy consistency between sectors should be in place. It will aid in establishing additional synergies and reducing trade-offs between national agricultural policies and climate commitments (through frameworks such as the Paris Agreement) and national agricultural policies and development priorities (through the Sustainable Development Goals). This needs good institutional coordination, transparent governance, and a long-term strategy. Second, more investments in climate-resilient agriculture are required. Financial incentives, subsidies, and availability of credit should enable governments to promote the use of climate-smart agriculture, agroforestry, and sustainable land management practices. Improved research and development systems will also contribute towards accelerating innovation and the spread of adaptive technologies. Third,

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capacity of farmers and extension services needs to be enhanced. The farmers can be empowered through training programs and climate advisory services coupled with knowledge sharing platforms to embrace sustainable practices and enhance productivity in face of the changing climatic conditions. Special focus will be the smallholder farmers who tend to be the most vulnerable. Fourth, inclusive gender and social inequality policies have to be promoted. To achieve a great deal with respect to food security and livelihoods in rural locations, women and marginalized groups should have equitable access to land, resources, technology and markets. Fifth, this can strengthen market systems and value chains which are more efficient and minimize food loss. This will boost the food distribution and income of the farmers through investing in infrastructure, storage and transportation systems and market availability. Finally, evidence-based decision-making necessitates data, monitoring and governance systems improvements. The implementation of policies and evaluation can be effective by providing credible data on climate change impacts, indicators of agricultural productivity, and food security.

6. Conclusion

Food security and climate change are structurally intertwined challenges that demand coordinated, long-term policy responses rather than parallel, sector-specific initiatives. The central finding of this chapter is that meaningful alignment between food security objectives and climate commitments is achievable, but contingent on governance effectiveness, adequate financing, and context-sensitive strategies that reflect regional heterogeneity across South Asia, Sub-Saharan Africa, Southeast Asia, and Latin America. This chapter has already discussed the intricate interplay between food systems and climate change and the need to incorporate food security into broader development agendas, such as the Sustainable Development Goals. It has also highlighted the necessity of striking a balance between synergies and trade-offs across industries and promoting sustainable and resilient agricultural practices. Some of the ways of achieving this alignment include sustainable land management, agroforestry, climate-smart farming, and technological innovation. They have managed to do so, though, because of conducive institutional structures, inclusive policies, and good governance. The shift towards sustainable food systems must be supported by a holistic approach that is well-oriented in the balance of environmental sustainability, economic viability, and social equity. International collaboration, investment in research and innovation, and empowerment of the community will have to be reinforced to address future adversities. In conclusion, climate action should be aligned with food security objectives as a strategic priority, not an afterthought. Future research should focus on quantifying trade-offs between agricultural intensification and biodiversity conservation, evaluating climate finance effectiveness in diverse institutional contexts, and generating longitudinal evidence on CSA adoption and food security outcomes across developing regions. Developing economies can offer food security not only to their citizens by taking comprehensive and sustainable strategies, but also help the world to achieve its climate targets.

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