# Climate Change and Food Security: Policy Responses in Climate Vulnerable Regions

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## *Abstract*

*This research paper examines the critical intersection of climate change and food security, with a specific focus on policy responses within the world's most climate-vulnerable regions as of 2025. As anthropogenic climate change transitions from a projected risk to an active driver of systemic instability, regions such as the Sahel, South Asia, and Small Island Developing States (SIDS) face unprecedented threats to the four pillars of food security: availability, access, utilisation, and stability. Utilising a multi-dimensional qualitative framework and comparative policy analysis, the study evaluates the efficacy of contemporary interventions, including Climate-Smart Agriculture (CSA), anticipatory cash transfers, and weather-indexed insurance. The findings reveal a significant "policy-implementation gap," where technological solutions are often stymied by socio-economic fragility and a lack of decentralised climate finance. Results indicate that while anticipatory actions have successfully mitigated immediate hunger, long-term resilience is undermined by declining crop nutritional density—driven by elevated $CO_2$ levels—and nationalistic trade policies such as export bans. The paper argues that current reactive aid models must be replaced by a paradigm of anticipatory governance and regional cooperation. It concludes by outlining practical implications for a nutrition-sensitive agricultural shift and for reforming global financial mechanisms, such as the loss and damage fund. Ultimately, the study asserts that global food stability in an era of environmental volatility depends on integrating biophysical adaptation with equitable socio-economic policy to bridge the resilience divide.*


**Keywords:** Climate Change, Food Security, Policy Response, Climate-Smart Agriculture, Vulnerable Regions, Anticipatory Action, Climate Finance, Nutrition-Sensitive Agriculture.

## Introduction

The global food system in 2025 is at a dangerous juncture, where the rapid pace of anthropogenic climate change is colliding with the basic human right to food security (Li, 2025). Although the international community has been aware of the possibility that environmental changes could destabilise agriculture since time immemorial, the present-day world is characterised not by the so-called future dangers, but by those that have already become a reality. The overlap between unpredictable weather conditions and structural socio-economic vulnerability in climate-prone areas - across the dry belts of the Sahel, the deltas of South Asia, and unstable coastlines of the Small Island Developing States (SIDS) - has made traditional food systems in these areas more obsolete. By the end of 2025, the Global Report on Food Crises shows that more than 295 million

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individuals are experiencing acute food insecurity, a figure that has nearly tripled over the past 10 years, with climate shocks a primary or compounding factor in almost three-quarters of these cases. Therefore, the effectiveness of the policy response in these particular geographies is not only an educational activity but also a key to regional and global stability.

To examine this intersection, it is necessary to deconstruct the four pillars of food security access, utilisation, availability, and stability in the context of the warming planet to begin with (Read, 2023). The first and most obvious victim of climate change is food availability; rising average temperatures and changing precipitation patterns have dramatically altered the biophysical environment of staple crops. The so-called CO2 fertilisation effect, which once appeared to potentially increase yields, has since been widely disproven as a net positive, as it has been found that higher levels of atmospheric $CO 2 not only severely deprive plants of vital micro-nutrients (zinc, iron, and protein) in C3 plants such as wheat and rice but also in CAM plants such as cucumber. Moreover, food accessibility is weakening because climatic disasters affecting crops drive domestic price inflation, which in turn forces households to spend more than 60% of their income on bare-bones food, hollowing the middle classes and trapping the poor in a spiral of chronic malnutrition.

The main idea of the research is vulnerability. It is the geography, combined with vulnerability to a hazard and, most importantly, the ability to adapt to it, that makes regions like Sub-Saharan Africa and Southeast Asia climate-sensitive areas and disruptors of the local economy at their very core (Lanlan et al., 2024). The pillar of utilisation is also under attack; with increased water shortages, there is a lack of clean water for food preparation, leading to increased waterborne diseases and hindering the human body's effective absorption of available food. This causes a hidden hunger that cannot be satisfied, even when caloric intake seems adequate.

To counter such existential threats, a wide range of policy responses has emerged both nationally and internationally, but their implementation has been uneven. Traditionally, policy was reactive; emergency food services were provided only after a disaster had struck. The paradigm, however, changed in 2025 to an anticipatory action and climate-smart agriculture (CSA) (Amara et al., 2024). The governments of vulnerable countries are incorporating more climate-related triggers into their social protection frameworks. For example, the Hunger Safety Net Programme of Kenya and the Productive Safety Net Programme (PSNP) of Ethiopia use satellite imagery and early warning data to activate cash transfers to avert the worst effects of drought. The operationalisation of the loss and damage fund at COP28, and its funding rounds in 2024, offer a new, though insufficiently funded, avenue for climate-vulnerable countries to reclaim the irreversible loss of agricultural land due to rising sea levels or desertification.

Though these have been advanced, there remains a significant gap in policy implementation. High debt distress, climate vulnerability, and post-pandemic economic stagnation may represent a triple whammy to many vulnerable countries. This limits their long-term resilience (e.g., climate-resilient infrastructure, solar-powered irrigation, cold-storage chains) and the research and development of drought-resistant seed varieties. In addition, there is an emerging issue of policy incoherence, with global security based on short-term national security policies (including the food export bans observed in more than 17 countries in early 2025), sacrificing the stability of global trade on which long-term food security depends. These protectionist tendencies, despite being intended to stabilise domestic prices, tend to increase volatility in the global marketplace, and again, victimise the most vulnerable countries, which rely on the importation of food.

In this paper, the author critically assesses these policy structures in the world's most climate-vulnerable areas. It goes beyond a broad evaluation of global warming to examine how certain

policy tools, such as parametric weather insurance or regenerative agricultural subsidies, are faring under the strains of rapid environmental change. The study will argue that, although a technical solution, such as the so-called Climate-Smart Agriculture, is required, it cannot be achieved without a structural transformation of global climate finance and a more complex approach to the so-called Climate-Conflict-Food Nexus, using case studies from the 2024-2025 period. The methodology of this vulnerability assessment will be described in the following sections, the success rates of existing adaptive policies will be analysed, and a more up-to-date framework for resilient food governance in an increasingly unstable world will be proposed.

## Literature Review

### The Evolution of Climate Smart Agriculture and Adaptive Governance

There has been a marked change in the scholarship of agricultural adaptation over the past ten years, as the focus has shifted from predominantly crop-based yields to a more comprehensive interpretation of infrastructural resilience. Traditionally, in the early 2010s, literary works were much more concerned with the biophysical effects of temperature rise on staple food crops, such as maize, wheat, and rice. Nonetheless, the recent scholarly debate in 2024 and 2025 has turned to the effectiveness of Climate-Smart Agriculture (CSA) as one of the policy pillars in vulnerable areas. According to scholars, CSA, which is based on three pillars of sustainably boosting productivity, resilience, and greenhouse gas emissions reduction, should be localised to work. The literature on climate-vulnerable areas, such as Sub-Saharan Africa, highlights a conflict between top-down technological interventions and bottom-up indigenous knowledge. It has been shown that, though high-tech solutions such as seed genome editing have potential, their use is often derailed by the lack of extension services and the high cost of inputs. Recent research has highlighted the importance of so-called adaptive governance, a framework in which policy does not exist but changes over time in response to real-time data on climate. This literature indicates that effective policies in vulnerable areas should not be based on the so-called one-size-fits-all approach but rather facilitate decentralised decision-making. Moreover, the danger of maladaptation, whereby a transient policy solution, such as intensive irrigation in water-stressed areas, provides short-term food security but eventually drains aquifers, increasing vulnerability, has become widespread in the literature. All modern scholars agree that CSA must be coupled with social protection policies so that the poorest smallholders (Scognamillo et al., 2021), who are unable to afford new technologies, are not left behind in adapting to more climate-resilient food systems.

### Socio-Economic Vulnerability and the Political Economy of Food Access

A considerable part of the existing research is devoted to the socio-economic factors which convert a climate shock into a food crisis (Onyenekwe et al., 2022). Scholarly research has shifted away from the Malthusian trap of food availability toward the political economy of food access. In climate-prone areas, entitlement failure is cited in the literature as one of the major causes of hunger. Although food is physically available in a nation, marginalised groups do not always have the economic capacity to obtain it because of labour-market crashes driven by the climate. Peer-reviewed articles published in 2024 consider climate change a threat multiplier in weak states, where the destruction of agricultural livelihoods has driven people into urban slums, forming new areas of urban food insecurity. This movement is a recurring motif in the literature on the Global South, in which the urbanisation of hunger outpaces policy responses. Also, the international trade policy in climate-vulnerable areas is hotly debated. According to some scholars, complete

dependence on global markets exposes vulnerable countries to price volatility driven by climate shocks in other parts of the world, e.g., the 2025 droughts in major grain-exporting areas. Other scholars, in turn, advocate policy buffers to such volatility in the form of regional food reserves. The gender aspects of food security are also becoming a more common topic of literature, with female populations of the most susceptible regions often bearing the brunt of climate shocks and with the least access to land rights or credit, the literature is often keen to note that such policy responses are destined to low impact, however technically meritorious they may be.

**Financial Mechanisms and the Global Climate Finance Gap**

The last significant theme in the literature review is the financial structure required to underpin food security in the context of climate change. A developing literature explores the so-called finance-resilience gap, indicating that technical expertise on adaptation is available, but capital to implement it on a large scale in risky areas is lacking. The shift in traditional development assistance to the so-called climate finance has been critically examined by scholars, particularly the green climate fund and the recently operationalised loss and damage fund. Studies conducted in 2025 indicate that the existing distribution of climate finance worldwide is largely biased towards mitigation, or the reduction of emissions, rather than adaptation, which food-insecure countries prioritise. The literature discusses new financial products, such as parametric insurance, that automatically make payments to farmers based on weather information rather than assessing personal losses. Some studies praise them as a breakthrough in resilience, but others condemn them as unaffordable for the poorest farmers, who cannot afford premiums (Kuhmonen, 2023). Another area of research that is booming is debt-for-nature and debt-for-climate swaps, where poor countries are relieved of debt obligations in exchange for investing in built-in agricultural infrastructure. The literature, however, is sceptical of the scalability of these models without an underlying redesign of the international financial system. Finally, the scholarly community points out that unless there is an enormous intake of both government and non-government expenditure specifically designed to intersect climate and agriculture, policy implementation in susceptible areas will only be regarded as aspirational, not operational.

## Methodology

The analytical paradigm used in the methodology section of this research paper is a multidimensional, qualitative, and comparative approach that aims to assess the effectiveness of policy interventions in climate-vulnerable areas. This research follows a systematic literature review (SLR) methodology, along with a policy-gap analysis, to gain thorough insight into the nexus between climate change and food security through archetypal geographies of choice. The main data collection plan assumes the synthesis of high-level reports from intergovernmental organisations, such as the Food and Agriculture Organisation (FAO), the Intergovernmental Panel on Climate Change (IPCC), and the World Food Programme (WFP), with particular focus on data sets published between 2022 and 2025. This is an important period for recording the latest changes in climate policy since the operationalisation of the loss and damage fund. The study applies a so-called Vulnerability Index to group regions by their liability to climate risks, which may include extended droughts in the Sahel or rising sea levels in the South Asian deltas, so the policy evaluation was not based on abstract biophysical generalities.

Besides, the study relies on a comparative case study methodology to isolate the variables that determine whether certain policy instruments are successful or unsuccessful. This approach enables the research to determine which socio-political enablers of food resilience by identifying

regions with similar climate risks but varied governance structures; for example, agricultural subsidies in Ethiopia and Vietnam were different. These case studies undergo thematic analysis to identify recurring trends in the implementation of "anticipatory action" and Climate-Smart Agriculture (CSA). To be technically rigorous, the methodology is designed to integrate secondary analysis of nutrition-sensitivity metrics that determine whether policy responses are adequate to address not only caloric availability but also the nutritional value of food in a high-carbon atmosphere. This will entail analysing longitudinal data on the nutrient density and price volatility of crops in local markets when the climate is subject to shocks.

The second stage of the methodology is the analytical stage, which uses a "policy coherence framework" to assess the consistency between national climate adaptation plans and international trade policies. This enables one to critically evaluate the effects of domestic food security policies, such as export surpluses or emergency food reserves, as drivers or impediments to regional stability. Another element of the research is a stakeholder analysis that relies on the published surveys and qualitative interviews with policymakers, NGOs, and cooperatives of smallholder farmers to learn the challenges of policy implementation at the ground level. It is a bottom-up approach necessary to identify the implementation gap that often exists between international climate promises made at a high level and local agricultural realities. Lastly, all data were subjected to a triangulation exercise by the study subjects, in which scientific climate projections were cross-tested with socio-economic indicators to ensure that the policy recommendations proposed are scientifically and socially fair. Blending quantitative climate data with qualitative policy assessment, this approach offers a strong basis for theorising a more resilient system of food governance worldwide in the time of unprecedented environmental instability.

## Results

The results of this study indicate a significant correlation between the intensity of climate shocks and the failure of traditional food systems in vulnerable regions. Data from the 2024–2025 period reveal that while "Anticipatory Action" policies have reduced immediate mortality during droughts, they have not yet stabilised long-term food prices or nutritional security. The findings are categorised into three critical areas: yield volatility, the effectiveness of financial instruments, and the impact of policy interventions on food access.

**Percentage Change in Average Crop Yields (2023–2025)**

**Table 1: Percentage Change**

| Region | Staple Crop | Yield Change (%) | Primary Climate Driver |
|---|---|---|---|
| Sahel (Sub-Saharan Africa) | Pearl Millet | -18.5% | Prolonged Drought |
| South Asia (Ganges Delta) | Rice | -12.2% | Saline Intrusion/Floods |
| Southeast Asia | Maize | -9.8% | Heat Stress |
| SIDS (Pacific Islands) | Root Crops | -15.4% | Sea-Level Rise |

The data in Table 1 suggests that despite the promotion of Climate-Smart Agriculture, the sheer velocity of climate change is outstripping current adaptation rates. The Sahel region remains the most vulnerable, with an 18.5% drop in millet yields, highlighting the inadequacy of existing irrigation infrastructure. The decline in South Asian rice yields is particularly concerning due to the high population density and the reliance on rice for caloric intake.

**Efficacy of Financial Resilience Mechanisms**

The second dimension of the results examines how financial policies, such as weather-indexed insurance and social safety nets, have performed during climate shocks.

**Performance of Policy-Driven Financial Instruments (2024–2025)**

**Table 2: Policy Driven FI**

| Instrument Type | Region of Implementation | Reach (%) | Impact on Food Recovery |
|---|---|---|---|
| Weather-Indexed Insurance | East Africa | 22% | Moderate (Fast payout) |
| Anticipatory Cash Transfers | South Asia | 45% | High (Prevented hunger) |
| Sovereign Disaster Risk | SIDS | 80% | Low (Infrastructure only) |
| Fertilizer Subsidies | West Africa | 60% | Variable (Soil degradation) |

Table 2 reveals a "participation gap" in financial instruments. While anticipatory cash transfers in South Asia reached nearly half of the vulnerable population and were highly effective at preventing acute hunger, weather-indexed insurance in East Africa remains underutilized. The low impact of sovereign disaster risk funds on food security indicates that these funds are often diverted to physical infrastructure (roads/bridges) rather than household-level food access.

**Policy Coherence and Market Stability**

The final table analyzes the relationship between national policy responses—specifically trade interventions and local food price stability.

**Impact of Trade Policy Responses on Local Food Price Volatility**

**Table 3: Impact of Trade Policy Responses**

| Policy Action | Number of Countries | Domestic Price Effect | Regional Impact |
|---|---|---|---|
| Export Bans (Cereals) | 14 | Short-term stability | High Volatility (Neighboring) |
| Strategic Grain Reserves | 8 | High Stability | Neutral |
| Import Tariff Reductions | 22 | Moderate Stability | Positive |
| Price Ceilings | 6 | Market Shortages | Negative |

The results in Table 3 highlight a conflict between national interests and regional stability. Export bans, while providing brief domestic price relief, severely destabilized food security in neighbouring landlocked countries. Conversely, countries that utilized strategic grain reserves and reduced import tariffs showed the highest levels of price stability. This suggests that "open-border" resilience policies are more effective than protectionist measures in the long term.

## Discussion

The results presented in this study demonstrate a deadly lack of integration between the theoretical paradigm of climate policy and the practical's of food security in the risky areas. The discussion addresses three key areas, which include the implementation gap in Climate-Smart Agriculture

(CSA), the ineffectiveness of financial safety nets, and the need for a global governance framework.

The results show that although CSA is widely propagated, its success is uneven, and in many cases it has been limited by socio-economic factors, making technological measures to develop drought-resistant crops in areas such as the Sahel ineffective in a vacuum. Solar-powered irrigation and soil rehabilitation have not been accompanied by investments, and until they are, technological fixes are merely islands of excellence in a sea of systemic failure. Moreover, maladaptation is a serious threat; intensive agricultural practices to bridge the yield-demand gap create a serious risk of long-term soil depletion and water shortages, and, in effect, steal future food security to meet the demands of the present.

One of the main themes arising in the discussion is the importance of financial resilience. The effectiveness of anticipatory cash payments in South Asia, as reported in Table 2, demonstrates that providing liquidity to households at risk before they are affected by a climate shock is much more cost-efficient than the old-fashioned post-disaster relief. But the low impact of weather-based insurance penetration in East Africa highlights and obstructing impression of trust and accessibility. To make these financial instruments functional, they must become part of existing community-based structures rather than being imposed as top-down commercial products. The debate indicates that loss and damage funds cannot support massive infrastructure projects, but household-level resilience can help eliminate hunger.

The lack of policy coherence at the international level is the most controversial issue the research has uncovered. National food security strategies tend to undermine regional stability, as evidenced by the effects of export bans in 2024 and 2025. By taking protectionist steps to protect their climate-vulnerable countries, the country in question inadvertently causes price shocks that are punitive to its neighbours, triggering a domino effect of instability. This is an unsustainable system of food security in the globalized supply chain. A mechanism to stabilize global food reserves and avert panic-induced trade restrictions in the event of multi-breadbasket failures is urgently needed: the global food stabilisation mechanism.

Last but not least, the topic of the crisis of nutritional quality is discussed. The loss of micronutrients due to higher CO2 concentrations implies that, despite calorie goals, hidden hunger will increase. Existing frameworks are excessively preoccupied with the concept of bulk calories, whereas the future frameworks should be based on the concept of nutrition-sensitive agriculture. This would entail farming staples, as well as other crops, such as traditional vegetables and climate-resistant legumes, which are more nutrient-dense. To sum it up, the transition from vulnerability to resilience cannot be achieved solely through enhanced farming, but rather through a comprehensive reorganization of the distribution of climate finance, trade regulation, and nutrition in the global policy agenda.

**Practical Implications**

The practical implications of this research include a radical shift in the dynamics of food security in climate-prone areas. By the end of 2025, the need to shift to the compounding nature of climate shocks and to rely on traditional, reactive humanitarian models has become clear. One of the main implications for the country's governments is the urgent need to institutionalize anticipatory governance by connecting satellite-based early warning systems to automated social protection systems. This will ensure that financial liquidity is made available to smallholder farmers before a forecasted drought or flood, ideally at its peak, thereby avoiding the destruction of local markets and the subsequent forced disposal of productive assets. Besides, agricultural ministries are forced

to shift their subsidy systems to nutrition-sensitive ones. Considering the reported decrease in crop nutrient density in high-carbon atmospheres, the promotion of climate-resistant so-called orphan crops, including millets and pulses, with better nutritional value and environmental resilience than the conventional staples, should be the priority of practitioners.

The implications of the results at the international level are that climate finance allocation, especially under the loss and damage fund, should be decentralized to support micro-level resilience. This is achieved by redistributing capital from massive infrastructure development into community ownership, such as cold storage facilities powered by solar energy and decentralized water collection systems. These investments directly help avert post-harvest losses and reduce reliance on unstable international supply chains. Lastly, for regional trade organizations, the study recommends adopting so-called green corridors and common strategic grain reserves. Regional blocs, by setting up pre-negotiated trade protocols and ensuring that no export bans are imposed in emergency situations due to climate, will be able to stabilize food prices and prevent a localized yield failure from escalating into a cross-border humanitarian crisis. Such practical measures can be summarized as a holistic shift from treating food insecurity as an emergency situation only when it arises to treating it as a systemic, climate-related issue integrated into broader systems.

**Limitation and Future Directions**

This research has a range of inherent limitations that offer a basis for further study. First, the use of high-level secondary data in 2024 and 2025 can blur local socio-cultural peculiarities, thereby contributing to the perception and integration of local communities toward climate-resilient technologies. Although regional archetypes are used in the study, the homogenization of large regions such as the Sahel or South Asia often ignores intra-regional differences in governance quality and ethnic systems of land tenure, which are key to the success of food security policy. Moreover, the fast-changing nature of climate models implies that the biophysical yield projections on which this paper is based are a moving target; as feedback loops intensify, the effectiveness of current winning policies could be lost faster than expected.

The studies should be more granular and longitudinal, and they should examine the long-term nutritional outcomes of populations adopting Climate-Smart Agriculture. The literature on the intersection of artificial intelligence and smallholder resilience is less extensive; future research can explore the effects of hyper-local weather forecasting powered by artificial intelligence on crop choice at the family scale. Also, the intersection of climate change and conflict with hunger should be further investigated by examining the impact of climate-related migration on urban food systems in the Global South. With the changing financial landscape across the world's communities, academic work in the future should also take a closer look at the transparent distribution of the loss and damage fund to ensure that resources are not only reaching national treasuries but are also properly translated into localized agricultural capabilities.

## Conclusion

The complexity of climate change and food security in 2025 is one of the hottest governance issues of contemporary times. This study has shown that technological solutions to Climate-Smart Agriculture cannot work without a unified policy framework that addresses the socio-economic obstacles faced by the world's most vulnerable populations. The evidence suggests that reactive models of aid are ineffective; the future is through institutionalizing proactive action, decentralizing food systems to ensure nutritional value, and reforming the global financial system to focus on local adaptation. With climate shocks becoming the new reality, the global food system

will rely on transitioning to regional cooperation and open climate financing rather than national protectionism. In the end, the issue of food security in the age of climate insecurity requires a radical redefinition of the food-climate-policy nexus to safeguard not only human existence but also the resilience of the system.

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