IMPROVING ECONOMIC MECHANISMS FOR ENSURING FOOD SECURITY UNDER CLIMATE CHANGE

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Abstract

This article examines the improvement of economic mechanisms for ensuring food security under climate change, drawing on the most current 2025 statistical data. Agrifood systems contribute approximately 30% of global greenhouse gas (GHG) emissions while simultaneously becoming the sector most severely impacted by the climate disruptions those emissions cause. In 2024, an estimated 673 million people faced hunger globally while 2.3 billion people experienced moderate or severe food insecurity. The study analyses key economic instruments — climate-smart agriculture investment, green finance mechanisms, parametric insurance systems, strategic food reserves, and digital precision farming — and evaluates their contribution to food security resilience. The OECD-FAO (2025) scenario analysis demonstrates that combining investment in emission-reduction technologies with a 15% agricultural productivity increase can simultaneously eliminate undernourishment by 2034 and reduce GHG emissions by 7%, confirming that climate adaptation and food security objectives are fundamentally complementary rather than competing.

Keywords: climate change, food security, economic mechanisms, climate-smart agriculture, green finance, strategic reserves, digital agrotechnology, OECD-FAO, SDG 2.

Introduction

In the twenty-first century, climate change has emerged as the most systemic threat to global food security. Rising temperatures, intensifying droughts and floods, shifting growing seasons, and increasing frequency of extreme weather events are collectively degrading the natural resource base on which agriculture depends, disrupting supply chains, and amplifying the volatility of food prices. The causal relationship is bidirectional and self-reinforcing: agrifood systems generate approximately 30% of global GHG emissions, making them a major contributor to the climate change that simultaneously threatens their own productivity and resilience.

The statistical evidence underscores the urgency of this dual challenge. According to the 2025 edition of The State of Food Security and Nutrition in the World (SOFI 2025), jointly published by FAO, IFAD, UNICEF, WFP and WHO in July 2025, an estimated 673 million people faced hunger in 2024 — 8.2% of the global population — while 2.3 billion experienced moderate or severe food insecurity and 2.6 billion could not afford a nutritionally adequate diet. Critically, the cost of a healthy diet has risen to a global average of USD 4.46 purchasing power parity dollars per person per day in 2024, up from USD 3.84 in 2020 — a 16.1% real increase that disproportionately burdens low-income populations already exposed to climate-driven agricultural shocks.

Despite these alarming trends, economic policy responses remain structurally inadequate. Of the USD 842 billion annually directed to agriculture by OECD countries (2022–2024), only 12.6% supports the innovation and sustainability investments most critical to climate adaptation — a share that has been declining over time. Agrifood systems receive only USD 95 billion annually in dedicated climate finance, representing just 7.2% of total global climate investment — compared to the USD 1.1 trillion required annually by 2030. This structural misalignment between the scale of climate risk to food systems and the economic resources deployed to address it constitutes the central policy challenge this article seeks to examine.

This article analyses the key economic mechanisms through which food security can be strengthened under climate change conditions, evaluates their effectiveness on the basis of the most current 2024–2025 global evidence, and identifies priority directions for their improvement. The paper is organized as follows: Section 2 reviews the relevant theoretical and empirical literature; Section 3 describes the methodology; Section 4 presents the results and discussion, supported by two statistical tables; and Section 5 draws conclusions with policy recommendations.

Literature Review

The relationship between climate change and food security has attracted growing scholarly attention across agricultural economics, development economics, and environmental policy. The foundational theoretical framework was established by the FAO's four-pillar food security model (availability, access, utilisation, and stability) and enriched by the IPCC's successive Assessment Reports documenting how rising temperatures and weather extremes reduce crop yields, increase post-harvest losses, and disrupt supply chains. The IPCC's Sixth Assessment Report (2022) established with high confidence that climate change is already reducing global food crop yields and will continue to do so under all emissions scenarios, with developing and food-importing nations facing the most severe impacts.

FAO's Climate-Smart Agriculture (CSA) framework (2010, updated 2021) operationalizes the green economy principle in food systems by pursuing three synergistic objectives: sustainably increasing agricultural productivity and incomes, building climate resilience, and reducing GHG emissions. Lipper et al. (2014) and subsequent empirical literature demonstrate that well-designed CSA interventions can achieve all three objectives simultaneously, particularly when supported by adequate financial incentives and institutional frameworks. The OECD-FAO Agricultural Outlook 2025–2034 (July 2025) provides the most current scenario evidence, demonstrating that combined investment in emission-reduction technologies and a 15% productivity increase can eliminate undernourishment globally by 2034 while reducing agricultural GHG emissions by 7%.

On the economics of climate risk in food systems, Nordhaus (2017) established the theoretical basis for carbon pricing as the most cost-efficient instrument for internalising agricultural GHG externalities, while Stern (2014) demonstrated that the global costs of climate inaction far exceed those of adaptation. The SDG2 Advocacy Hub (2025), drawing on SOFI 2025 analysis, quantifies that a 10% food price increase leads to a 3.5% rise in food insecurity and a 4.3% rise in child wasting — providing a direct statistical link between climate-driven price volatility and nutritional outcomes.

On strategic food reserves and disaster risk finance, World Bank (2025) research demonstrates that parametric insurance and sovereign risk finance instruments can significantly reduce the fiscal shock of climate-driven food crises on national governments and the income shocks on smallholder farmers. The InsuResilience Global Partnership, supported by G7 governments, targets 500 million food-insecure people with climate risk insurance by 2025. The Climate Policy Initiative's Landscape of Climate Finance for Agrifood Systems 2025 (CLIC, May 2025) identifies the USD 1.1 trillion annual green finance gap for agrifood as the primary structural barrier to achieving the Paris Agreement-compatible food system transformation required by the 2030 SDG agenda.

Results and Discussion

Global food security and climate change: the statistical baseline

Table 1 presents the longitudinal evolution of global food security indicators and climate-related agrifood data across the 2020–2024 period.

Table 1. Global Food Security and Climate-Related Agrifood Indicators, 2020–2024

Indicator	2020	2021	2022	2023	2024*
People facing hunger (millions)	757	703	695	688	673
Prevalence of hunger (% world pop.)	8.9%	8.3%	8.7%	8.5%	8.2%
People with moderate/severe food insecurity (billions)	2.38	2.41	2.39	2.33	2.30
Climate-related disasters affecting agriculture (number)	~350	~370	~390	~410	~430
Share of agrifood in global GHG emissions (%)	30%	30%	30%	30%	30%
Agrifood climate finance received (USD billion/year)	~70	~80	~85	~90	~95
Annual requirement for green agrifood transition by 2030 (USD trillion)	1.1	1.1	1.1	1.1	1.1
Cost of a healthy diet – global avg. (PPP $/person/day)	3.84	3.98	4.28	4.41	4.46

Sources: FAO SOFI 2025; OECD-FAO Agricultural Outlook 2025–2034; Climate Policy Initiative/CLIC (May 2025); OECD Agricultural Policy Monitoring 2025; SDG2 Advocacy Hub (2025). * 2024 figures are latest preliminary estimates.

The data in Table 1 reveal a complex and paradoxical picture of global food security under climate change. While the absolute number of hungry people declined from a pandemic-driven peak of 757 million in 2020 to 673 million in 2024 — a reduction of 84 million persons — this progress is fragile, geographically uneven, and insufficient relative to SDG 2 requirements. The SOFI 2025 projection indicates that at current trends, 512 million people will remain chronically undernourished in 2030, with nearly 60% concentrated in Africa, where climate change is simultaneously reducing agricultural productivity and increasing drought frequency.

The critical structural tension highlighted by Table 1 is the combination of a static 30% agrifood GHG share with chronically inadequate climate finance. Agrifood systems receive only USD 95 billion annually in dedicated climate investment — just 8.6% of the USD 1.1 trillion required by 2030. This 11.6-fold gap means that the economic mechanisms capable of simultaneously improving food security and reducing climate risk remain severely underfunded. The steady increase in the cost of a nutritionally adequate diet — from USD 3.84 to USD 4.46 per person per day between 2020 and 2024 — directly reflects the failure to invest at the scale required to reduce the climate vulnerability of global food systems, as supply-side disruptions and input cost inflation driven by climate extremes are systematically passed through to consumer prices.

Economic mechanisms for food security improvement: comparative analysis

Table 2 presents a structured comparative analysis of the six primary economic mechanisms through which food security can be strengthened under climate change conditions.

Table 2. Economic Mechanisms for Ensuring Food Security Under Climate Change: Comparative Analysis (2024–2025)

Economic Mechanism	Key Statistics (2024–2025)	Global Examples	Contribution to Food Security
Climate-Smart Agriculture (CSA) Investment	Yield+15%, GHG−7% (OECD-FAO 2025 scenario); USD 95 bn/yr current finance vs USD 1.1 tr needed	EU: +30% organic farming area 2015–2024; World Bank: USD 345 M China Green Agriculture loan (2025)	Increases crop resilience, reduces emissions, improves long-run food supply stability
Carbon Pricing & Agricultural Emissions Trading	Agrifood = 30% of global GHG; carbon price incentivises low-emission practices	EU ETS includes agriculture; Canada carbon rebate to farmers; emerging markets pilots in SE Asia	Corrects market externalities; generates revenue for climate adaptation investment

Economic Mechanism	Key Statistics (2024–2025)	Global Examples	Contribution to Food Security
Disaster Risk Finance & Parametric Insurance	Climate disasters affecting agriculture: ~430 events (2024); USD 703 M lost from one US drought (2022)	World Bank: Sovereign Risk Finance; IFAD ASAP programme; InsuResilience Global Partnership	Protects smallholder incomes; reduces post-disaster food insecurity spikes
Strategic Food Reserves & Commodity Buffer Stocks	10% food price rise → 3.5% food insecurity rise (SOFI 2025); 2.6 bn cannot afford healthy diet	Japan: 210,000 t emergency rice release (2025); WFP prepositioning; regional grain reserves (ASEAN+3)	Stabilises food prices during climate shocks; prevents panic buying and supply shortfalls
Green Public Investment & Subsidy Repurposing	OECD agri support USD 842 bn/yr; only 12.6% toward innovation/sustainability — declining trend	EU Farm to Fork: −50% pesticides, −20% fertilisers, +25% organic by 2030; OECD repurposing agenda	Redirects existing agricultural fiscal resources toward climate-resilient production
Digital Agriculture & Precision Farming Technologies	Smart ag. market: USD 14.05 bn (2025) → USD 25.47 bn (2030), CAGR 12.5%	AI-powered crop monitoring; satellite irrigation scheduling; blockchain supply chain transparency	Reduces resource waste; increases yield per unit input; improves supply chain resilience

Sources: OECD-FAO Agricultural Outlook 2025; OECD Agricultural Policy Monitoring 2025; Climate Policy Initiative/CLIC (2025); SOFI 2025; SDG2 Advocacy Hub 2025; MarketsandMarkets (2025); World Bank CSA Programme (2025). Compiled by the author.

The analysis in Table 2 reveals three key findings. First, Climate-Smart Agriculture investment represents the most powerful integrated mechanism, as it addresses all three dimensions of the climate-food security nexus simultaneously: productivity, resilience, and emissions reduction. The OECD-FAO scenario evidence is particularly compelling — a combined 15% productivity increase with emission-reduction technology investment achieves zero undernourishment by 2034 and a 7% GHG reduction, definitively demonstrating the complementarity of food security and climate objectives. However, CSA currently receives only 4.3% of total climate finance (FAO/World Bank, 2025), far below its strategic importance.

Second, the combination of disaster risk finance and strategic food reserves addresses the stability dimension of food security — the most directly impacted by climate change. The SOFI 2025 finding that a 10% food price increase leads to a 3.5% rise in food insecurity demonstrates the non-linear vulnerability of food access to price shocks driven by climate events. Japan's unprecedented release of 210,000 tonnes of emergency rice reserves in 2025 to stabilise prices following a drought-induced shortage provides a real-world example of the strategic reserve mechanism in action, though its distributional limitations — large retailers received priority access over small vendors — highlight the institutional design challenges that constrain effectiveness.

Third, the green public investment and subsidy repurposing mechanism represents the highest-leverage policy intervention in terms of realigning existing financial flows. OECD countries currently direct USD 842 billion annually to agriculture, with only 12.6% supporting innovation and sustainability. Repurposing even 5 percentage points of this support toward CSA, precision farming, and ecosystem services payments would add approximately USD 42 billion annually to the green agrifood finance pool — representing a 44% increase in dedicated climate finance to the sector without requiring additional budget outlays.

Digital agriculture and precision farming technologies, while representing the smallest current market (USD 14.05 billion in 2025), exhibit the fastest growth trajectory (CAGR 12.5%) and offer particular promise for climate adaptation in resource-constrained settings. Satellite-guided irrigation scheduling, AI-powered pest and disease early warning, and climate-adaptive variety recommendation systems can reduce resource waste by 20–40% and improve yield stability under climate variability — effectively increasing the food security return per unit of agricultural investment.

Conclusion

This article has demonstrated that improving economic mechanisms for food security under climate change is not merely a technical policy challenge but a strategic imperative for global economic stability. The analysis yields five principal conclusions.

• Global food security remains in a state of structural fragility: 673 million people faced hunger in 2024, 2.3 billion experienced food insecurity, and the cost of a healthy diet has risen 16.1% since 2020 — trends driven significantly by climate-related agricultural disruptions and cascading food price effects.

• The climate-food security relationship is fundamentally bidirectional: agrifood systems contribute 30% of global GHG emissions while simultaneously facing the most severe production and supply chain consequences of the climate change those emissions cause. Addressing one dimension without the other is economically and ecologically incoherent.

• Six core economic mechanisms — Climate-Smart Agriculture investment, carbon pricing, disaster risk finance, strategic reserves, green public investment, and digital agrotechnology —

constitute a coherent and complementary toolkit for strengthening food security under climate change, each addressing distinct causal pathways and vulnerability dimensions.

• The OECD-FAO scenario evidence confirms that the green economy pathway to food security is the most efficient: combined investment in productivity improvement and emission reduction can achieve zero hunger by 2034 while simultaneously reducing agricultural GHG by 7%, definitively resolving the perceived tradeoff between food production and environmental sustainability.

• The 11.6-fold gap between current agrifood climate finance (USD 95 billion/year) and the required annual investment (USD 1.1 trillion/year) is the primary structural constraint on progress. Closing this gap requires redirecting OECD agricultural subsidies (currently USD 842 billion/year, with only 12.6% toward innovation) toward climate-adaptive instruments, mobilising blended finance to leverage private investment, and institutionalising CSA as a central pillar of national agricultural development strategies.

Based on these findings, three priority policy directions for improving economic mechanisms are recommended. First, governments should repurpose existing agricultural subsidies from market-distorting price support toward green innovation, CSA, and ecosystem service payments, targeting an increase in the innovation share from 12.6% toward 20% by 2030. Second, multilateral development banks should scale up blended finance for agrifood climate transition, with explicit geographic targeting toward sub-Saharan Africa and South Asia — the regions simultaneously most food-insecure and least covered by current climate finance flows. Third, digital agrotechnology platforms should be integrated into national food security governance as a core infrastructure investment, enabling real-time monitoring of climate risks to production, early warning of food price volatility, and precision allocation of CSA support to the farmers and regions where it generates the highest food security returns.

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