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Climate Change as the Primary Driver of Price Volatility in Agriculture: Evidence, Mechanisms, and Adaptation Pathways

Sachin Rathour, Tushar Anand, Pratibha Rani and Khushboo

Department of Agricultural Economics & Extension Education, Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior. Pine Code: 474002. Madhya Pradesh, India.

*Corresponding Author

Sachin Rathour*

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INTRODUCTION

Agriculture remains one of the most climate-sensitive sectors of the global economy. Unlike manufacturing or services, agricultural production is biologically dependent on temperature, rainfall, soil moisture, and ecological stability. As climate change accelerates, these foundational conditions are increasingly disrupted, resulting in unstable production patterns and heightened price volatility.

Price volatility in agriculture is not a new phenomenon; markets have always responded to variations in supply and demand. However, the *frequency*, *intensity*, and *geographical spread* of price shocks have increased markedly in the 21st century. What distinguishes the current phase is the systemic nature of climate change, which affects multiple regions and commodities simultaneously, thereby weakening the ability of markets and institutions to absorb shocks.

The present article is rooted in the reflections of postgraduate scholars who participated in an interactive discussion session on climate change and agricultural price volatility. The discussion emphasized that while climate change may not always act alone, it increasingly functions as a *primary driver* that interacts with and magnifies other sources of volatility. The article therefore adopts a nuanced position: climate change is not the sole determinant of price volatility, but it has become the most pervasive and structurally embedded factor shaping agricultural markets.

Climate Change and Agricultural Price Volatility: Conceptual Linkages

Climate change refers to long-term shifts in temperature, precipitation patterns, and the frequency and intensity of extreme weather events. Agriculture, being intrinsically dependent on climatic conditions, is particularly vulnerable to such changes. Unlike industrial production, agricultural output is biologically constrained and operates within narrow climatic thresholds. Consequently, even minor deviations in temperature or rainfall can result in significant yield fluctuations.

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Agricultural price volatility primarily arises from sudden imbalances between supply and demand. Climate-induced events such as droughts, floods, cyclones, and heatwaves directly disrupt crop production, leading to abrupt supply shocks. These shocks translate into sharp price increases, especially for essential food commodities with inelastic demand. According to the Intergovernmental Panel on Climate Change (IPCC, 2023), global surface temperatures have already risen by approximately 1.1°C above pre-industrial levels, significantly reducing yield stability for major crops such as wheat, rice, and maize. As buffer stocks weaken under repeated climate shocks, markets become increasingly sensitive to even small production shortfalls.

In this context, climate change acts not merely as an external shock but as a systemic force that amplifies existing vulnerabilities within agricultural markets. Its effects are pervasive, influencing production, storage, transportation, and trade, thereby making it a dominant driver of price volatility.

Mechanisms of Climate-Induced Price Fluctuations

One of the most critical mechanisms through which climate change induces price volatility is yield compression caused by heat stress. Empirical studies indicate that for every 1°C increase in global mean temperature, wheat yields decline by approximately 6 percent (Lobell et al., 2011). When major breadbasket regions experience simultaneous heatwaves, global supply contracts sharply, resulting in price spikes—a phenomenon increasingly referred to as "heatflation."

Erratic rainfall patterns further compound this problem. Excess rainfall can cause flooding and waterlogging, destroying standing crops, while prolonged droughts lead to moisture stress and crop failure. Changes in rainfall timing also affect sowing decisions, crop maturity, and harvest quality. These disruptions introduce uncertainty into agricultural markets, prompting farmers, traders, and processors to incorporate higher risk premiums into prices.

Another important mechanism is the "bullwhip effect" within food supply chains. Small production shocks at the farm level often get magnified as they move through intermediaries, wholesalers, and retailers. Climate-induced uncertainty encourages speculative hoarding, export restrictions, and panic buying, all of which exacerbate price volatility. The Food and Agriculture Organization (FAO, 2018) highlights that climate shocks often trigger policy reactions such as export bans, which further destabilize global markets.

Empirical Evidence from Historical and Contemporary Events

Historical and contemporary examples strongly support the climate–price volatility nexus. The Irish Famine (1845–1849) remains one of the earliest documented cases where a climate-related biological shock—the potato blight caused by *Phytophthora infestans*—destroyed the staple food crop, leading to massive food shortages, price escalation, and human suffering.

In recent times, the locust attacks during 2019–2020, coinciding with the COVID-19 pandemic, provide a compelling example of compound crises. Climate conditions conducive to locust breeding, combined with pandemic-induced supply chain disruptions, resulted in significant crop losses across South Asia and East Africa. In India and Pakistan, crops such as wheat, pulses, oilseeds, cotton, maize, sugarcane, chickpea, sunflower, vegetables, and spices like cumin and coriander were heavily damaged. These losses led to supply shortages and sharp price volatility, particularly for cereals and vegetables. Governments responded through buffer stock releases, imports, and export bans, underscoring the scale of the crisis.

Another striking example is the unprecedented rise in tomato prices in India during July–August 2023, when retail prices reached approximately ₹200 per kilogram in several cities. This surge was primarily driven by unseasonal rainfall, heatwaves, and a reduction in cultivated area in major producing states. Heat stress caused blossom end rot due to calcium absorption failure, while sudden rainfall during fruit ripening led to fruit cracking, rendering produce unmarketable. Although prices stabilized once fresh supplies arrived, the episode vividly demonstrated how climate variability can destabilize food prices even in short periods.

Crop-Specific Vulnerabilities and Quality-Induced Price Effects

Climate change affects not only the quantity of agricultural output but also its quality, which has important price implications. In states like Rajasthan and Gujarat, sudden heatwaves during seed filling and maturity stages have caused seed coat darkening in crops such as cumin at temperatures exceeding 30–35°C. This deterioration reduces essential oil content, germination capacity, and storability, often resulting in export rejection and significant economic losses for farmers.

Similarly, excess rainfall and waterlogging in garlic cultivation lead to root rot and bulb decay, reducing yields and market supply. These shortages can encourage black marketing and artificial scarcity, further aggravating price volatility. Poor quality output also limits farmers' access to premium markets, compounding income instability.

Rice crops are increasingly threatened by pests such as the Brown Plant Hopper (BPH), whose incidence has intensified under changing climatic conditions. BPH causes "hopperburn" and transmits viral diseases like Rice Grassy Stunt Virus and Rice Ragged Stunt Virus, leading to stunted growth and crop failure. These biological stresses reduce effective supply, pushing prices upward, particularly in rice-dependent regions.

Regional Vulnerabilities and the Indian Context

The impact of climate-induced price volatility is uneven across regions. Tropical and subtropical regions, particularly South Asia and Sub-Saharan Africa, are disproportionately affected due to their heavy reliance on rainfed agriculture. In India, where a large proportion of cropped area depends on monsoon rainfall, climate variability has a direct and immediate effect on agricultural output and prices.

Recent years have witnessed severe losses in kharif crop production across the Gangetic plains due to excessive rainfall and flooding. Punjab, traditionally considered a stable agricultural region, has also faced significant production losses due to floods. These disruptions directly affect farmgate prices and subsequently translate into retail inflation. The Reserve Bank of India (RBI, 2022) has acknowledged climate-induced food inflation as an emerging macroeconomic concern.

At the global level, climate shocks in major exporting countries transmit volatility across borders. For instance, droughts affecting wheat production or excessive rainfall impacting cocoa in West Africa have led to global price surges, demonstrating the interconnected nature of food markets.

Farm-Level Adaptation Strategies

At the farm level, adaptation is the first line of defense against climate-induced price volatility. Crop diversification is a critical strategy for spreading climatic risk and stabilizing farm income. Farmers cultivating multiple crops are less vulnerable to total income loss when one crop fails.

The adoption of climate-resilient and stress-tolerant varieties, such as heat-tolerant tomato varieties like Sun Pride and Sun Master, can significantly reduce yield losses. Efficient water management practices, including drip irrigation and rainwater harvesting, help mitigate the effects of drought and erratic rainfall.

Integrated farming systems offer another promising pathway. By combining crops with livestock, fisheries, or agroforestry, farmers can ensure year-round income and employment, reducing dependence on a single commodity whose price may be volatile. Intercropping further enhances resource use efficiency and risk distribution.

Market-Based Adaptation and Risk Management

Market instruments play a crucial role in managing price risks arising from climate variability. Futures and options markets enable farmers and traders to hedge against price uncertainty by locking in prices in advance. While access remains limited for smallholders, institutional support and capacity building can enhance participation.

Warehouse receipt systems allow farmers to store produce and sell when prices are favorable, preventing distress sales during periods of excess supply caused by sudden favorable weather. Weather-based crop insurance schemes provide compensation during droughts, floods, and extreme weather events, stabilizing farm income and reducing panic selling.

Access to timely and reliable market information regarding prices, weather forecasts, and demand trends empowers farmers to make informed decisions, improving market efficiency and reducing volatility.

Policy Interventions and Institutional Support

Policy-level interventions are essential to complement farm and market-based adaptations. Investment in irrigation, storage infrastructure, and climate-resilient supply chains enhances the capacity of markets to absorb shocks. Strengthening minimum support price (MSP) mechanisms, procurement systems, and buffer stocks helps stabilize prices during supply disruptions.

Predictable trade policies are particularly important. Sudden export bans, while intended to protect domestic consumers, often exacerbate global price volatility. Coordinated and transparent trade policies can reduce uncertainty and improve market stability.

Extension services and farmer education play a pivotal role in promoting climate-smart agricultural practices. Educating farmers about recommended fertilizer use, soil health management, and sustainable production practices not only enhances productivity but also reduces vulnerability to climate shocks.

Emerging Pathways: Carbon Credits and Climate-Smart Agriculture

Climate-smart agricultural practices such as conservation agriculture, agroforestry, and reduced fertilizer use offer dual benefits of mitigation and adaptation. These practices enable farmers to generate carbon credits, providing an additional and relatively stable income stream. Participation in carbon markets can reduce dependence on volatile crop prices and incentivize sustainable farming.

The integration of advanced technologies such as AI-based weather forecasting, precision agriculture, and improved crop genomics holds significant promise for enhancing resilience. However, equitable access to these technologies remains a key challenge.

CONCLUSION

The evidence presented through scholarly discussion and empirical examples clearly indicates that climate change has transitioned from being a peripheral environmental issue to a central economic driver of agricultural price volatility. Price fluctuations in agriculture are no longer mere market anomalies but symptoms of deeper climatic disruptions affecting production systems worldwide.

Addressing this challenge requires a multi-layered approach that integrates farm-level adaptation, market-based risk management, and supportive policy frameworks. Sustainable solutions lie in the synergy between technological innovation, institutional reform, and farmer-centric education. Without such coordinated interventions, agricultural markets risk entering an era of persistent volatility, threatening food security and the livelihoods of millions, particularly smallholder farmers.

The insights presented in this article reflect the collective understanding developed through interactive academic engagement and underscore the urgency of reorienting agricultural systems toward climate resilience and economic stability.

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REFERENCES

FAO. (2018). *The State of Agricultural Commodity Markets*. Rome.

FAO. (2021). *The State of Food Security and Nutrition in the World*. Rome.

IPCC. (2023). *AR6 Synthesis Report*. Geneva.

Lobell, D. B., Schlenker, W., & Costa-Roberts, J. (2011). Climate trends and global crop production. *Science*, 333(6042), 616–620.

RBI. (2022). *Report on Currency and Finance*. Mumbai.

World Bank. (2019). *Managing Weather Risks and Climate Change in Agriculture*. Washington, DC.