

Why Extreme Weather Is Becoming Every Farmer's Biggest Challenge

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Abstract

Extreme weather events have increased in frequency, intensity, and unpredictability across the world, posing escalating risks to agricultural production. In India, where nearly half of the population depends on farming, these changes have direct implications for food security, livelihoods, and national economic stability. This article explores the scientific basis behind extreme weather trends and their impacts on crop growth, soil systems, pests and diseases, farm economics, and adaptation pathways. Using global and India-specific evidence, it highlights why extreme weather is emerging as the most formidable challenge for farmers today.

1. Introduction

Agriculture depends heavily on stable weather patterns. Traditionally, farmers have relied on predictable monsoons, seasonal temperature cycles, and established climatic rhythms to plan crop calendars, irrigation schedules, and input use. However, over the past few decades, these patterns have become increasingly erratic. India has witnessed more frequent heatwaves, prolonged dry spells, unseasonal rains, sudden cloudbursts, cyclones, and floods (IPCC, 2022; IMD, 2023).

Scientific assessments, including the Intergovernmental Panel on Climate Change Sixth Assessment Report (AR6), confirm that climate-induced extreme events are accelerating globally and disproportionately affecting agriculture (IPCC, 2022). As a result, farmers—particularly smallholders are facing unprecedented uncertainty and risk in production decisions.

2. Understanding Extreme Weather Trends

Extreme weather refers to climate events that fall far outside historical averages. Several interconnected trends are increasingly influencing agricultural systems in India.

2.1 Rising Frequency of Heatwaves

India has recorded a sharp increase in heatwave frequency and duration. Observations from the India Meteorological Department indicate that central and northwestern India now experience more heatwave days annually, with summer maximum temperatures frequently exceeding 45°C (IMD, 2023).

2.2 Increased Heavy Rainfall and Cloudbursts

Although total monsoon rainfall has not declined uniformly, its temporal and spatial distribution has become highly erratic. IMD analyses show that extreme rainfall events have increased by more than 75 per cent in several Indian states over the past three decades, increasing flood risks and crop damage (IMD, 2023).

2.3 Extended Dry Spells and Drought

The monsoon season is increasingly characterized by short periods of intense rainfall followed by prolonged dry spells. This pattern disrupts soil moisture availability and crop water demand. A regional analysis published in *Nature Communications* reported a significant increase in drought frequency across South Asia since 2000 (Singh *et al.*, 2020).

2.4 More Intense Cyclones

The Arabian Sea, historically less active than the Bay of Bengal, is now producing more intense cyclones. Climate modelling and observational studies indicate rising cyclone intensity affecting coastal regions of Gujarat, Maharashtra, and Karnataka (Resmi *et al.*, 2021).

2.5 Unseasonal Rains and Temperature Fluctuations

Unseasonal rainfall during harvest periods, sudden cold spells during flowering, and warmer-than-normal winters are increasingly reported by farmers. These anomalies disrupt crop phenology and often promote pest outbreaks (IMD, 2023).

3. How Extreme Weather Affects Crop Production

3.1 Heat Stress Reduces Yield and Quality

Crop plants function within specific thermal thresholds. When temperatures exceed these limits:

- ❖ Pollination is impaired in cereals such as wheat, maize, and rice
- ❖ Grain-filling duration is shortened
- ❖ Elevated night temperatures increase respiratory losses

Experimental and field studies by the Indian Council of Agricultural Research show that a 1°C rise in minimum temperature can reduce wheat yields by 4–5 per cent in northern India (ICAR, 2020).

3.2 Erratic Rainfall Disrupts Crop Calendars

Excess rainfall leads to waterlogging, nutrient leaching, delayed sowing, lodging, and flower drop, while delayed monsoon onset postpones planting operations and reduces yield potential (IMD, 2023).

3.3 Flooding and Soil Erosion

Flooding can destroy standing crops within hours. Repeated flood events alter soil texture through silt deposition, while surface runoff removes fertile topsoil, reducing long-term productivity (FAO, 2016).

3.4 Drought Limits Crop Growth and Seed Germination

Soil moisture stress delays germination, restricts root growth, and reduces nutrient uptake. Pulses, oilseeds, and vegetable crops are particularly sensitive to drought conditions (World Bank, 2021).

3.5 Unseasonal Rains Damage Harvested Crops

Rainfall during harvest seasons has increased in several regions, leading to sprouting, fungal infections, grain discolouration, quality deterioration, and reduced market prices (IMD, 2023).

Overall, extreme weather exerts multidimensional pressure on crop productivity and stability.

4. Impacts on Pests, Diseases, and Weeds

4.1 Warmer Temperatures Accelerate Insect Growth

Insects are ectothermic organisms, and higher temperatures accelerate their development. This leads to increased generations per season and higher pest pressure during critical crop stages. Pests such as whiteflies and armyworms are now reported more frequently across regions (World Bank, 2021).

4.2 Expansion of Invasive Pests

Climate change facilitates the establishment and spreads of invasive pests, including fall armyworm, rugose spiralling whitefly, and tomato pinworm. Warmer winters improve overwintering survival and geographic expansion (World Bank, 2021).

4.3 Disease Emergence

High humidity and elevated temperatures favour fungal and bacterial diseases such as rice blast, vegetable wilts, and pulse rusts, increasing disease incidence and severity (FAO, 2016).

5. Effects on Soil Health and Water Resources

5.1 Soil Degradation

Heavy rainfall accelerates erosion, while drought leads to soil crusting and reduced microbial activity. Both extremes contribute to declining soil organic carbon levels (FAO, 2016).

5.2 Disrupted Nutrient Cycles

High temperatures increase nitrogen volatilization, while intense rainfall causes nutrient leaching and runoff, lowering fertilizer-use efficiency and increasing production costs (FAO, 2016).

5.3 Water Scarcity

Droughts reduce groundwater recharge, and over-extraction during dry periods intensifies water scarcity. This heightens vulnerability during subsequent drought years (World Bank, 2021).

5.4 Salinization in Coastal Areas

Cyclones and storm surges cause saltwater intrusion into agricultural lands, damaging paddy fields and horticultural crops in coastal regions (Resmi *et al.*, 2021).

6. Economic Implications for Farmers

6.1 Increasing Production Costs

Farmers face rising expenditures on irrigation, re-sowing, pesticides, fertilizers, and labour required for emergency protective measures (ICAR, 2020).

6.2 Higher Risk of Crop Failure

Even well-managed crops may fail under extreme weather conditions. Crop insurance claims have increased sharply in climate-vulnerable districts, reflecting growing production risk (ICAR, 2020; IMD, 2023).

6.3 Market Instability

Weather shocks disrupt supply chains, causing sharp price spikes during shortages and market gluts following localized bumper harvests, increasing income volatility for farmers (World Bank, 2021).

7. Conclusion

Extreme weather has become one of the most formidable challenges facing modern agriculture because it disrupts every component of the farming system—from soil health and crop physiology to pest dynamics and farm profitability. As climate change intensifies, India's agriculture must transition toward climate-resilient practices, improved forecasting, sustainable resource management, and stronger institutional support systems. Without timely adaptation, extreme weather threatens food security, rural livelihoods, and national economic stability. Understanding its scientific basis and agricultural impacts is essential for building a resilient farming future.

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