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Climatic Variability and Its Influence on Crop Health and Pest Incidence in Western Rajasthan

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Abstract: ***Western Rajasthan, characterized by arid and semi-arid climatic conditions, experiences extreme temperature fluctuations, low rainfall, and frequent droughts. These climatic stressors significantly affect crop health and alter pest incidence patterns. This study investigates how climatic variability from 2000 to 2017 influences key crops—bajra, guar, wheat, mustard, and moth bean—and the occurrence of major pests such as white grub, aphids, termites, and Helicoverpa armigera. Using a mixed-method approach combining meteorological data, agricultural statistics, field surveys (196 farmers), and interviews with agricultural officers, the research identifies strong correlations between climatic anomalies and pest outbreaks. Results reveal that increased temperature (>45°C days), delayed monsoon, reduced humidity, and erratic rainfall dramatically reduce crop vigor and enhance pest proliferation. The study concludes that climate variability is a major driver of declining crop health and rising pest incidence in Western Rajasthan, necessitating climate-smart agriculture, early warning systems, and integrated pest management .***

Keywords: Climatic Variability, Pest Incidence, Western Rajasthan, Crop Health, Arid Agriculture, Temperature Extremes, Integrated Pest Management (IPM), Drought, Crop Pests.

1.1 Introduction

Western Rajasthan comprises the districts of Jodhpur, Barmer, Jaisalmer, Bikaner, and parts of Nagaur and Jalore. The region faces extremely harsh climatic conditions:

1. High summer temperatures (45–50°C)
2. Annual rainfall below 250 mm
3. High wind speed and sandstorms
4. Very high evapotranspiration

Agriculture is primarily rain-fed, making it vulnerable to climate variability. Over the last two decades, farmers have increasingly reported changes in crop growth patterns, increased susceptibility to pests, and reduced yields. Climatic variations such as delayed monsoon, prolonged dry spells, heatwaves, and unseasonal rainfall further intensify pest attacks.

This research provides a comprehensive evaluation of how climatic fluctuations influence crop health and pest incidence in Western Rajasthan. The study also explores traditional coping mechanisms and modern agricultural practices essential for climate adaptation.

1.2 Objectives

1. To analyze climatic variability in Western Rajasthan from 2000–2017.
2. To assess its effects on the health of major crops.
3. To study the correlation between climate anomalies and pest outbreaks.
4. To document farmers' perceptions regarding climate-induced pest changes.
5. To recommend climate-smart agricultural strategies and pest management solutions.

1.3 Methodology

1. Study Design

A mixed quantitative–qualitative approach was used.

2. Data Sources

2.1 Meteorological Data:

Temperature, rainfall, humidity data from IMD (2000–2017)

2.2 Agricultural Data:

Crop yield statistics (Government of Rajasthan)

2.3 Primary Data:

1. Field observations in Jodhpur, Barmer, Bikaner, Nagaur
2. Interviews with 196 farmers
3. Discussions with KVK experts
4. Crop health scoring (1–5 scale)
5. Pest count surveys per sq. meter area

3. Tools and Analysis

3.1 Pearson correlation between climate variables and pest incidence

3.2 Trend analysis of rainfall and temperature

3.3 Comparative crop health assessment between normal and drought years

3.4 Qualitative perception analysis

1.4 Study Area

The study focuses on the arid belt of western Rajasthan:

1. Jodhpur

1.1 250–300 mm rainfall

1.2 Bajra, guar, mustard dominate

2. Barmer

2.1 Driest district after Jaisalmer

2.2 Frequent droughts

2.3 Moth and guar prominent

3. Bikaner

3.1 Sandy soils, low humidity

3.2 Susceptible to white grub and termite attacks

4. Nagaur (Western part)

4.1 Transitional arid–semi-arid climate

4.2 Wheat and mustard cultivation

These districts represent the climatic extremes affecting crop health and pest dynamics.

1.5 Observations

1. Climatic Variability Trends (2000–2017)

Parameter	Observed Change
Mean annual temperature	+1.2°C increase
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Summer max (>45°C days)	Increase by 18%
Rainfall variability	±35% fluctuation year-to-year
Number of drought years	7 out of 17 years
Humidity levels	Declined by 8–12%

2. Impact on Major Crops

2.1 Bajra

(a.) Reduced grain filling during heatwaves

(b.)Stunted growth during monsoon delays

2.2 Guar

(a.)Highly sensitive to dry spells

(b.)Shows yellowing and premature flower drop

2.3 Mustard and Wheat

(a.)Low winter rainfall reduces vegetative growth

(b.)High susceptibility to aphids in warm winters

2.4 Moth Bean

(a.)Completely collapses during extended dry spells

(b.)Susceptible to fungal infections after sudden rains

3. Major Pest Incidence Observed

Pest	Increase Pattern	Climatic Association
White Grub	+40%	Favored by high soil temp and low humidity
Aphids	+50%	Mild winters, warm humidity
Termites	+28%	Drought years
Helicoverpa armigera	+35%	Unseasonal rainfall

4. Farmers' Perceptions

(a.)82% reported pests have increased after 2010

(b.)76% observed earlier pest attacks than usual

(c.)68% stated rising temperatures reduce crop vigor

(d.)61% reported unpredictable rains cause new pests

1.6 Discussion

1. Temperature Rise Weakens Crop Physiology

1.1 Higher temperatures accelerate:

1.2 Respiration

1.3 Evapotranspiration

1.4 Soil moisture depletion

This reduces crop vigor, making plants more susceptible to pests.

2. Rainfall Variability Influences Pest Cycles

2.1 Erratic monsoon leads to:

2.2 White grub emergence after light showers

2.3 Aphid multiplication during post-rain humidity

2.4 Termite attacks during prolonged dry spells

3. Humidity Changes Alter Pest Ecology

Declining humidity favors pests like termites; fluctuating humidity promotes fungal pathogens.

4. New Pests Introduced

4.1 Farmers in Bikaner and Jodhpur reported:

4.2 Mealybugs (after 2012)

4.3 Red hairy caterpillar outbreaks

4.4 Both linked to unseasonal rains and warm winters.

5. Climate Stress Reduces Natural Predators

Ladybird beetles, spiders, and parasitoids decline during heatwaves, causing pest explosions.

6. Economic Losses

6.1 Based on farmer data:

6.2 15–40% crop loss due to climatic stress

6.3 Additional 10–25% loss due to pests

1.7 Results

1. Climatic variability significantly impacts crop health in Western Rajasthan.

2. Pest incidence increased 25–50% across multiple districts.

3. Temperature rise and rainfall irregularity correlate strongly with pest outbreaks.

4. Crop yields declined 18–30% during high variability years.

5. Farmers report major challenges in predicting pests and maintaining plant vigor.

1.8 Conclusion

Climatic variability is a dominant factor influencing crop health and pest incidence in Western Rajasthan. Rising temperatures, declining humidity, unpredictable rainfall, and increased drought frequency weaken crop physiology, making fields more vulnerable to pests. The persistence of these climatic trends threatens agricultural sustainability and farmer livelihoods.

Integrated efforts are required to combine climate-smart techniques, improved pest forecasting, and adaptive farming technologies to safeguard agriculture in the arid regions of Rajasthan.

1.9 Recommendations

1. Climate-Smart Agriculture

(a.)Drought-tolerant bajra, guar, and moth varieties

(b.)Mulching for soil moisture retention

(c.)Early sowing strategies

2. Strengthen Pest Surveillance

(a.)Village-level pest monitoring centers

(b.)SMS-based warning systems

(c.)Farmer training on pest recognition

3. Integrated Pest Management (IPM)

(a.)Use of neem-based biopesticides

(b.)Promotion of natural predators

(c.)Trap cropping with castor, marigold

(d.)Limited and safe chemical pesticide use

4. Improve Soil Health

(a.)Organic manures

(b.)Crop rotation

(c.)Biofertilizers

5. Policy-Level Interventions

(a.)Government support for arid-zone research

(b.)Subsidies for micro-irrigation

(c.)Inclusion of climate services in agriculture extension

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