WHEAT PRODUCTION: GEOGRAPHY

NEWS: How climate change affects India's wheat production

WHAT'S IN THE NEWS?

India recorded its warmest February in 124 years, putting wheat crops at risk due to climate change-induced heat stress. Studies predict increased heatwaves, which could lower wheat yields and quality, impacting both domestic production and global supply.

Record Warm February and Heat Stress on Wheat

- India has recorded its warmest February in 124 years, leading to significant concerns over the growing impacts of climate change. This warmer-than-usual February was followed by heat warnings for March 2025, indicating an early onset of extreme temperatures.
- Wheat, India's second-most consumed crop after rice, is facing significant threats due to these temperature changes. The elevated heat stress is expected to affect wheat yields across the country, further exacerbating food security concerns.

Impact of Climate Change on Wheat

- A 2022 study published in the *International Journal of Molecular Sciences* found that global warming negatively affects wheat in several ways:
    - **Reduction in Grain Production and Quality**: As temperatures rise, wheat plants experience heat stress, which diminishes both the quantity and the quality of the grain produced. This results in lower yields and lower quality of wheat for consumption and processing.
    - **Disruption of Key Physiological and Biochemical Processes**: The rise in global temperatures disrupts critical processes such as photosynthesis, respiration, and nutrient absorption in wheat plants. These disruptions hinder the plant's ability to efficiently convert sunlight into energy, absorb water and nutrients, and produce grains effectively.
- A 2024 study by the Indian Institute of Tropical Meteorology, Pune, made alarming predictions regarding the future impacts of climate change on the Indian Ocean. The study forecasts that the Indian Ocean will enter a "near-permanent heatwave state" as a result of global warming.
- The frequency of marine heatwaves, which directly affect climate patterns and agricultural systems, is expected to increase dramatically, from 20 days per year to 220-250 days per year. This would significantly affect the local and global weather systems, further intensifying heatwaves and adding stress to crops like wheat.

Effects of Heat Waves on Wheat

- **Acceleration of Flowering and Ripening**: Heatwaves shorten the grain-filling period of wheat by accelerating the flowering and ripening processes. While this may seem beneficial initially, it ultimately leads to lower grain weight and quality.

- **Reduced Starch Accumulation**: High temperatures interfere with the wheat plant's ability to accumulate starch in its grains, leading to lighter, smaller grains. This directly results in lower yields and poorer milling quality.

- **Increased Protein Content but Lower Starch**: While heat stress can cause the wheat to have a higher protein content, the reduced starch levels make the wheat less suitable for milling. This imbalance lowers the overall quality of the wheat, especially for industries reliant on wheat for flour production.

Wheat Cultivation in India

- Wheat is classified as a **Rabi crop**, meaning it is sown between **September and December** and harvested between **February and May**. The Rabi cropping season allows wheat to benefit from cooler weather during its early stages of growth and warmer, dry conditions at the ripening stage.

- India cultivates wheat over approximately **29.8 million hectares**, making it one of the largest wheat-producing nations globally.

- The primary wheat variety cultivated in India is **soft to medium-hard wheat**, which has a **medium protein content**. This variety is similar to the U.S. hard white wheat and is typically used for baking and general consumption.

- **Durum wheat**, also known as pasta or macaroni wheat, is a high-quality wheat variety grown in India, prized for its superior quality and higher protein content.

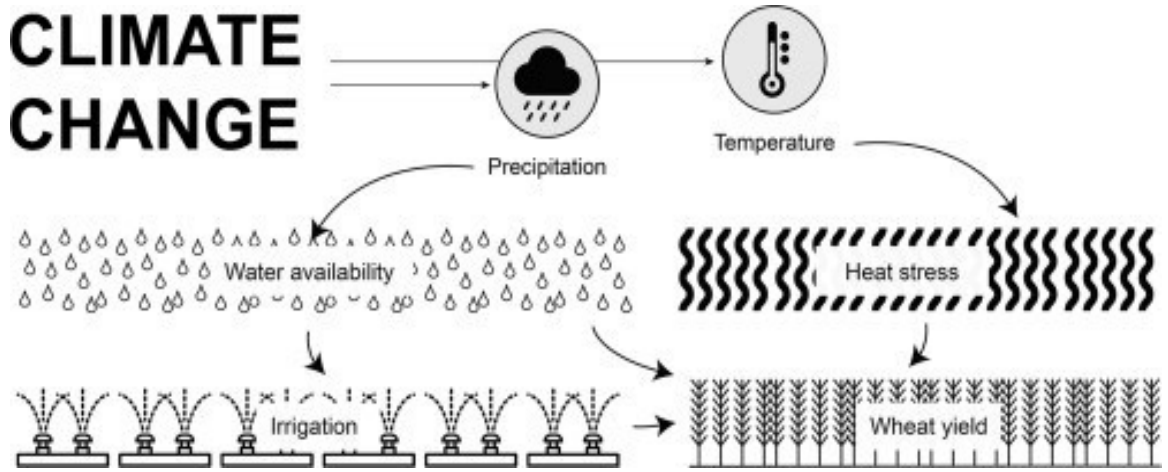
Adaptability and Climatic Conditions for Wheat

- **Wide Adaptability**: Wheat is a highly adaptable crop that can be grown in a variety of climatic zones, including tropical, sub-tropical, temperate zones, and cold regions as far as 60°N latitude. This adaptability allows wheat to be grown in many parts of the world.

- **Climate Tolerance**: Wheat can tolerate extreme cold and snow, allowing it to resume growth in spring when the weather warms up. This resilience to varying temperatures makes it a valuable crop in diverse climatic conditions.

- **Altitude Range**: Wheat is cultivated in a wide altitude range, from **sea level** up to **3,300 meters**. The ability to grow in high-altitude regions adds to wheat's versatility in terms of geography.

- **Ideal Climate**: Wheat grows best in regions where the weather is cool and moist during its growth phase. It requires a dry, warm climate for ripening, which is essential for high-quality grain production.
- **Germination Temperature**: Wheat seeds germinate best at a temperature range of **20-25°C**, though they can also germinate at temperatures as low as **5°C** and as high as **35°C**. However, extreme temperatures can lead to poor germination or stunted growth.
- **Ripening Temperature**: The ideal temperature for ripening wheat is around **14-15°C**, which ensures that the grain matures fully, resulting in high yields and good quality.
- **Climate Sensitivity**:
    - **Excessive Rain after Sowing**: Too much rainfall after sowing can hinder the germination process, leading to poor crop establishment.
    - **Extreme Temperatures during Flowering**: Both excessively high and low temperatures during the flowering stage can cause significant damage to the wheat crop, affecting both the quantity and quality of the final yield.



Key Stages of Wheat Growth (According to the FAO)

- **Germination to Emergence**: This is the initial stage where the wheat seed germinates, and the seedling begins to emerge. During this phase, the plant develops its first leaf, marking the start of its growth.
- **Growth Stage 1**: From emergence to the double ridge stage, the plant begins to form its primordial leaves and spikelets. This is the phase where the plant starts to build its basic structure.
- **Growth Stage 2**: The double ridge to anthesis phase marks the reproductive stage, where the wheat plant begins to form its reproductive organs. This is the most

vulnerable stage for heat stress, as high temperatures can severely affect the formation of flowers and spikelets.

- **Growth Stage 3**: The grain-filling period, from anthesis to maturity, is critical for determining the final yield. It is during this phase that the wheat plant accumulates starch in the grains, leading to the development of full-sized, heavy grains. Heat stress during this period can severely reduce yield and quality.

Indian and Global Wheat Production

- **Top Wheat Producers in India**:
    - **Uttar Pradesh** is the largest producer of wheat, followed by **Madhya Pradesh**, **Punjab**, **Haryana**, and **Rajasthan**. These states together contribute a significant portion of India's wheat production.

- **Global Wheat Production**: The top wheat producers globally are **China**, the **European Union**, and **India**, together contributing over 41% of the world's wheat output.

- **Top Wheat Exporters**: The largest exporters of wheat are **Russia**, the **United States**, **Canada**, **France**, and **Ukraine**. These countries dominate the global wheat export market.

- Despite its large production, **India** is a **net importer** of wheat, and its global wheat exports are relatively minimal compared to other major producers like Russia and the U.S.

- **Ukraine and Russia**: These two countries contribute a combined **14%** of global wheat production. Ukraine ranks **4th**, and Russia ranks **7th** in global wheat production.

This detailed breakdown explains how climate change, particularly rising temperatures and heatwaves, is affecting wheat production both in India and globally, emphasizing the need for adaptation strategies in wheat cultivation to protect future yields.

Source: **https://www.thehindu.com/sci-tech/agriculture/climate-change-impact-on-wheat-production-in-india/article69306516.ece#:~:text=%E2%80%9CHigh%20temperatures%20cause%20early%20flowering,State%20University%2C%20told%20The%20Hindu**