Climate Change, Trade Policies and Agricultural Sustainability in India under WTO Framework

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ABSTRACT

Agriculture is still very important for India's economy, supporting many people's daily lives and helping the country to have sufficient food and develop its rural area. However, the sector is dealing with more problems because of climate change like higher temperature, unpredictable rain, drought and floods, worse soil quality and greater use of natural resources.at the same time India's agriculture works with in the rule set by International trade policies from the World Trade Organisation (WTO). These policies affect how much support the government gives to farmers, how to sell crops in the market, how well Indian agriculture can compete with other countries and how long farming can stay healthy and productive. The correlation between trade policies and climate change has resulted in both opportunities and challenges for achieving sustainable agricultural development in India. This paper looks at how climate change and trade policies affect the sustainability of agriculture and discusses the policies needed to make Indian agriculture more resilient. The study uses a descriptive and analytical approach, depending on secondary data gathered from reports and publications by the world trade organisation, food and agriculture organisations, Ministry of Agriculture and farmer's welfare, NITI Ayog, and other government and international organisation. The study shows that climate change has negatively impacted farming output, farmer's income, the availability of food, especially for small and marginal farmers. Even though opening up trade has given farmers more chances to sell their crops abroad, it has also made them more vulnerable to change in global prices, strict requirement for product quality and stronger competition from other countries. The study says that developing agriculture in a sustainable way needs a combined approach with policies that include farming methods that can handle climate change, managing natural resources, smart government investments, using new technology and trade rule that follow WTO standards. To make farming more resilient and ensure there is enough food for the future, it is important to improve research and support services, use farming method that work well with the climate, encourage exports of different products in a sustainable way and provide better support systems for farmers in India.

Keyword: **Climate Change, sustainability of agriculture, World Trade Organisation, International trade policies**

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Introduction:

In India, agriculture is essential to economic growth, rural livelihoods, job creation and food security. The agricultural sector continues to sustain a significant amount of nations population and is crucial for maintaining social stability and nutritional security, even though its share of GDP has gradually decreased. However, the negative effects of climate change are becoming more common in Indian agriculture, posing serious obstacles to agriculture output, the preservation of natural resources and the

livelihoods of millions of farmers. One of the biggest risks to the development sustainable agriculture is climate change. Crop productivity, soil fertility, water availability and biodiversity have all suffered as a result of rising temperatures, erratic rainfall patterns, floods, cyclones and other extreme weather events. Production risks have increased as a result of climate uncertainties, especially for small and marginal farmers that rely mostly on rain-fed agriculture and have limited capacity for adoption. As a result, maintaining agricultural sustainability is now one of the India's top policy priorities.

Agricultural trade policies have become more significant in influencing the competitiveness and performance of the agriculture industry in addition to climate problem. India has matched its agricultural trade policies with the principles of the Agreement on Agriculture (AOA), which prioritizes market access, domestic support and export competition, since joining the WTO in 1995. Trade liberalization has made it possible to increase agricultural exports, draw in investment, and integrate Indian agriculture into International market, but it has also made farmers more vulnerable to global competition and price fluctuations. These developments have caused significant discussions about environmental sustainability, farmer welfare and food security.

Sustainable agriculture necessitates striking a balance between social justice, environmental preservation and economic prosperity. Sustainable agricultural development requires innovative technology, effective resource management, climate resilient farming methods and favourable trade regulations. Therefore, developing measures that improve agricultural resilience while upholding International trade commitments requires an understanding of how climate change and trade policy interact.

In light of this, the current study investigates the connection between trade policy, agricultural sustainability and climate change in India. The paper evaluates the difficulties presented by the International trade law and climatic variability using secondary data and policy analysis. It also finds ways to advance climate smart agriculture, boost export competitiveness and improve food security. The results are anticipated to add to the current policy discussion on attaining sustainable agricultural development in India in the context of changing International commerce.

Review of Literature :

The Intergovernmental panel on Climate change(IPCC,2023) reported that rising temperatures, changing perception pattern, and increasing frequency of extreme weather events have significantly affected global agricultural systems. The reports emphasized that developing countries, including india are particularly vulnerable because agriculture remains highly dependent on climatic condition.

According to Pingali(2012), the green revolution sustainability increased agricultural productivity in India through improved seed varieties, irrigation and fertilizer use. However, the study also highlighted concerns regarding groundwater depletion, soil degradation and environmental sustainability, suggesting that future agricultural growth should focus on resource efficient farming system.

Birthal, Roy, and Negi(2015), examined crop diversification as a strategy for improving farmer's income and reducing rural poverty. Their findings indicated that diversification towards high value crops could increase farm profitability and strengthen resilience against production and market risks

Chand(2012), analysed agricultural policies and market reforms in India and argued that improved market access, efficient value chains, and supportive government policies are essential for increasing farmer's income and enhancing agricultural competitiveness.

The World Trade Organisation(WTO)(2024) emphasized that the agreement on agriculture provides a frame work for regulating agricultural trade through market access, domestic support, export competition.although trade liberalization has expanded export opportunities, developing countries continue to face challenges related to subsidy

disciplines, market access barriers and compliance with International quality standard.

The Food and Agriculture Organisation(FAO, 2023) stressed that sustainable agrifood system requires integrated policies that promote environmental conservation, efficient resource utilization, climate adaptation and inclusive agricultural growth.

Gulati and Saini(2018) highlighted that increasing farmer's income requires comprehensive reforms in agricultural marketing, irrigation, technology adaption, value addition and export promotion. They argued that greater investment in agricultural infrastructure and market oriented policies can significantly improve agricultural competitiveness while ensuring sustainability.

Finally Niti Aayog (2023) emphasized the importance of climate smart agriculture, digital technologies, efficient water management and institutional reforms for achieving sustainable agricultural growth. The report recommended integrating climate adaptation strategies with agricultural and trade policies to streangthen resilience and improve farmer's livelihoods.

Research Gap

The effects of climate change on crop productivity, the management of natural resources and the livelihoods of farmers have all been well studied in the literature now available on Indian agriculture. Comparably, a significant amount of study has examined how trade liberalization and WTO affects agricultural exports, market access, subsidies and food security. But most of the research on these problems has been done separately. Research on trade policy places more emphasis on institutional and economic factors than on environmental sustainability, whereas studies on climate change mostly concentrate on issues relating to production and the environment. As a result, there are not many studies that combine trade policies, agricultural sustainability and climate change into a cohesive analytical framework for India. Addressing this gap is essential for understanding how climate risks and International trade regulations jointly influence sustainable agricultural development. The present study bridges this gap by examining the interrelationship between climate change, WTO related trade policies and agricultural sustainability, thereby providing policy recommendations for resilient and sustainable agricultural growth in India.

Objectives of the study

- To investigate how climate change affects Indian agriculture and what that means for agricultural sustainability and productivity.
- To examine how trade policies, especially those that fall under the WTO framework, support India's agricultural sustainability.
- To determine the main obstacle and possibilities brought about by the relationship between agricultural trade policies and climate change.
- To make suitable policy recommendations for improving India's long term food security, sustainable agricultural development and climate resilience.

Research Methodology

The current study uses a descriptive and analytical research design to investigate how trade policies, climate change and agricultural sustainability are related in India. The evolution of agricultural trade policies, shifting climate circumstances and their consequences for sustainable agricultural development are all explained using the descriptive approach. The analytical method makes it easier to evaluate comparisons, trends and legislative initiatives affecting the agriculture industry.

The study is solely based on secondary data that was gather from reputable domestic and foreign sources. The Food and Agriculture Organisation (FAO), the World Trade Organisation(WTO), the Ministry of Agriculture and farmer's welfare, the Government of India, the National Institution for Transforming India (NITI Aayog), the Ministry of Commerce and Industry, the reserve bank of India and research studies. These resources include thorough data on trade performance, agricultural output, climatic indicators and policy advancements.

The study's 2010-2025-time frame allows for an evaluation of current developments in India's agricultural output, trade policy changes, climate variability and sustainability programs. Significant advancements in agricultural policy reforms, climate adoption tactics, and India's involvement in International trade are all captured during this time.

Trend analysis is used to look at variations in trade performance, agricultural output and climate variables over time in order to meet the study's goals. Key indicators pertaining to agriculture and climate are summarised and presented using descriptive statistics. While policy analysis is done to determine how well current trade and agricultural policies support sustainable agricultural growth, comparative analysis makes it easier to evaluate changes across time periods and policy contexts combining these analytical methods yields a thorough understanding of how trade policies, agricultural sustainability and climate change interact in India and serve as the foundation for policy suggestions.

Climate Change and Indian Agriculture

One of the biggest issues influencing the sustainability of Indian agriculture is climate change. Changes in temperature, rainfall and the frequency of extreme weather events have a significant impact on crop output, natural resource management and farmer's livelihoods because agriculture in India is still heavily reliant on climate conditions. Food security and the agricultural sector's long-term viability are at risk due to the growing severity of climate related hazards. The increase in average temperatures is one of the most obvious consequences of climate change. During their reproductive stage, major crop including rice, wheat and legumes are especially vulnerable to heat stress. The shifting rainfall patterns are another big worry. India's monsoon has become increasingly, irregular, marked by delayed onset, early departure and unequal distribution. Such rainfall fluctuation affects sowing schedules, crop growth and harvesting procedures. The rising frequency and intensity of droughts and floods have further worsened agricultural vulnerability. Droughts deplete soil moisture, limit irrigation availability, and damage standing crops, whereas, floods ruin agricultural land and damage rural infrastructure.

In many part of India, crop productivity has decreased, as a result of climate change. Pest infestations, soil deterioration, heat stress and erratic precipitation all work together to lower agricultural yields and raised production instability. In rain-fed regions, where farmers have less access to irrigation and contemporary agricultural methods, the negative methods are more noticeable.

Soil deterioration, which is brought on by increased soil erosion, nutrient depletion and decreasing organic matter, is another significant effect. Prolonged droughts lower soil moisture biological activity, whereas heavy rains and floods erode fertile topsoil.

Due to decease ground water levels, diminishing surface water resources and heightened competition for water among domestic, industrial and agricultural sector, water scarcity has grown in importance. Reduced water availability has a major impact on irrigation, crop intensity and overall agricultural production because agriculture uses the majority of fresh water in India.

Trade Policy and agricultural Sustainability

Trade policy plays a crucial role in influencing agricultural sustainability by determining market access, government support, export performance and the efficient use of natural resources. etic support and subsidies remain essential for Indian agriculture, particularly for small and marginal farmer's government support through input subsidies, minimum support price, public procurement and agricultural credit helps stabilize farm income and enhance production. Redirecting subsidies towards climate resilient technologies, efficient irrigation, renewable energy and sustainable farming practices can improve both productivity and environmental conservation.

Market access gives Indian farmers the chance to diversify their output, export agricultural products and boost farm revenue. However, infrastructure,

productise and quality must all be improved in order to compete internationally. In order to preserve domestic food supplies and manage inflation, governments also implement export limitations such as export tariffs or temporary bans.

In order to access international markets, adherence to sanitary and phytosanitary(SPS) regulations is becoming more and more crucial. Although small farmers frequently need technical and financial support to satisfy. These requirements, adhering to international food safety and quality standards boosts customer confidence and increases export potential. Exports of agricultural products support employment creation, economic expansion and foreign exchange profits. However, by supporting sustainable farming practices, minimising over-reliance on chemical inputs and promoting efficient resources use, export led growth should be balanced with environmental sustainability. By encouraging climate smart technologies, sustainable irrigation, organic farming, green value chains and investments in agricultural research and innovation, trade policies can further promote climate resilient agriculture.

Challenges and opportunities

Climate, economic, and institutional issues all have an impact on India's efforts to achieve agricultural sustainability. The agricultural industry has faced a number of difficulties as a result of climate change and changing trade regulations, but they have also offered new chances to support resilient and sustainable agricultural development.

Increasing climatic variability, which has led to erratic rainfall, rising temperatures, frequent droughts, floods and cyclones is one of the main issues. Cropping pattern have been disturbed, agricultural productivity has decreased and production risks have grown as a result. The bulk of Indian farms are smell and marginal landholdings, which further restricts their capacity to invest in contemporary technologies, irrigation infrastructure and climate adaption strategies. A significant amount of Indian agriculture is still reliant on monsoon rainfall due to a lack of irrigation facilities, making it more susceptible to weather variations.

Sustainable agricultural development can be supported by a number of opportunities notwithstanding these limitations. Climate smart agriculture, which includes conservation agriculture, drought tolerant crop types, effective irrigation methods, and better water management, can increase climate change resilience while preserving productivity. Opportunities to produce high value agricultural goods with less of an impact on the environment are presented by the growing demand for organic farming. Farmers can make well informed decisions about crop management, weather forecasts and market access thanks to digital agriculture, which is backed by mobile applications, artificial intelligence, remote sensing and precision farming technologies. Developing sustainable value chains through improved storage, processing, transportation, and certification system can minimize post-harvest losses, increase farmer's income and promote environmentally responsible agricultural growth. Collectively these opportunities can strengthen the resilience, competitiveness and sustainability of Indian agriculture in an increasingly dynamic global environment.

Policy Recommendations

An integrated policy framework that concurrently address trade competitiveness, climate change and farmer's livelihoods is necessary for India to achieve sustainable agricultural development. The creation and widespread distribution of climate resilient crop type that can withstand pests, drought, floods and heat stress should a top priority for the government. These kinds can increase output and lessen farmer's susceptibility to shifting weather patterns.

Enhancing environmental friendly irrigation system is similarly crucial. Water use efficiency can be increased while conserving limited water resources by expanding micro- irrigation techniques like drip and sprinkler irrigation, supporting effective groundwater management and increasing rainwater gathering. Additionally, rather than encouraging excessive use of chemical inputs, green agricultural subsidies should be pushed by offering incentives for organic farming, the use of renewable energy, bio

fertilizers, precision farming and other environmentally friendly agricultural methods.

Sufficient remuneration for losses brought on by climate related calamities. Increasing insurance coverage and streamlining claim settlement processes can improve farmer's financial security and resilience. In order to foster innovation in climate smart technology, better crop varieties, and sustainable farming methods, increased funding for agricultural research and development is crucial. Strengthened agricultural extension service should be used to efficiently spread these advances, allowing farmers to implement new technologies and better management techniques.

By promoting quality certification, value addition, organic farming and adherence to international sanitary standards, trade policy should assist the growth of sustainable agricultural exports. Agricultural competitiveness can be increased while preserving environmental sustainability by building export oriented infrastructure and expanding farmer's access to international markets.

Conclusion:

Two of the most important elements influencing Indian agriculture's future are climate change and foreign trade policies. Farmer's livelihoods, food security and agricultural output have all suffered as a result of rising temperatures, unpredictable rainfall, frequent droughts and floods, deteriorating soil health and growing water scarcity. Simultaneously, India's membership in WTO has made it possible to increase agricultural exports, extend market access and boost competitiveness internationally. However, trade liberalization has also made agricultural sustainability a difficult policy issue by exposing farmers to global price swings, strict quality standards, and growing competition.

The study emphasizes the need for a balanced strategy that incorporates trade policy goals with climate adaptation in order to achieve sustainable agricultural development. In addition to increasing productivity and exports, agricultural policies should guarantee resource efficiency, environmental preservation and farmer's financial security. The agricultural sector's resilience against climate related hazards can be greatly increased by placing more focus on climate smart agriculture, sustainable irrigation, green technologies, organic farming and effective market mechanisms.

In conclusion, successful coordination of climate policy, agricultural reforms and international trade agreements is essential to India's sustainable agricultural development. India can ensure the long-term sustainability of its agricultural sector while strengthening food security, raising farmer's income conserving natural resources and improving its standing in the global agricultural market by implementing a comprehensive and forward-looking policy strategy.

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