TEMPERATURE SHOCKS AND AGRICULTURAL OUTPUT IN NIGERIA: A DYNAMIC COMPUTABLE GENERAL EQUILIBRIUM APPROACH

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ABSTRACT

This study investigated the effect of temperature shocks on agricultural output in Nigeria using the Dynamic Computable General Equilibrium (DCGE) model. By examining the effects of temperature rise, the study provided valuable insights into the influence of extreme weather conditions on agricultural output in Nigeria. Data was obtained from the 2019 social accounting matrix (SAM). The estimation involved a simulation, which was conducted to determine both the short term and long-term effects of temperature shocks. The findings of the study showed that higher temperatures would result in a decrease in agricultural output in both the short and long term. The study therefore emphasized the need for proactive policies towards countering the negative effect of high temperature in the agricultural sector. Policies should also seek to influence the behavior of economic agents such that their economic activities do not contribute to higher temperature and heat levels.

Keywords: Temperature, Agricultural output, Crops, Livestock, Simulation, Nigeria

JEL Classification Codes: C68; G28; Q54; Q11; Q01

1. INTRODUCTION

Agriculture holds significant importance in the economic landscape of Nigeria prior to the 1970s, making a substantial contribution of around 70 percent to the country's foreign exchange and employing over 80 percent of the entire labor force (Adeyinka *et al*., 2014). It is worth emphasizing that agriculture played a crucial role in the overall Gross Domestic Product (GDP) during various time intervals. Notably, from 1981 to 1989, the average contribution of agriculture to total GDP was approximately 38.1 percent. Furthermore, from 1990 to 1999, this contribution increased to an average of 39.3 percent. Lastly, from 2000 to 2006, the agricultural sector's contribution to total GDP reached an average of 42.0 percent (CBN, 2010).

Nevertheless, the agricultural industry has been encountering below-average performance in recent times. By way of illustration, in 2015, agriculture contributed 3.7 points to GDP, but this increased slightly to 4.1 points in 2016, before falling to 3.4 points in 2017 and hovering around 2.1 to 2.2 points from 2018 to 2020 in Nigeria. Agriculture sector growth was 1.22 per cent in the third quarter of 2021, linked with 1.39 per cent in the comparable quarter of 2020. The decline is triggered by increased temperature (CBN,2021). The decline in agricultural production is also manifested through increased food insecurity and malnutrition among Nigeria's expanding population (Anumudu et al., 2018).

A plausible explanation for this trend may be the fact that agricultural households in Nigeria, akin to most developing countries, encounter diverse shocks, particularly droughts and temperature rise, leading to adverse effects on agricultural productivity and food security, especially among rural households (Ogheneruemu & Opeyemi, 2023). This results in the depletion of saving and resource accumulation among farmers, and ultimately constraining agricultural output growth prospect in the future (Oduntan & Obisesan, 2022).

Dell et al. (2014) noted that temperature rise plummets agricultural sector contribution to GDP. Intuitively, ADB (2022) avers that between 2050 and 2070, minimum temperature increase could range from 1.48°C to 1.78°C while maximum temperature increases ranges from +3.08°C to +3.48°C in Nigeria. The annual mean temperature in the southern region ranges from 17°C to 37°C, while in the northern region, it varies between 12°C to 45°C. Over the period from 1901 to 2016, the countrywide temperature has shown a gradual increase of 0.03°C per decade.

Temperature rise has had adverse effects on the environment, including the drying up of Lake Chad. The lake's land area has decreased from over 40,000 km2 to a mere 1,300 km2. Additionally, the Sahara Desert has been encroaching on surrounding areas due to the elevated temperatures. The deviation from moderate temperature pattern portends both direct and indirect multipliers. Direct consequences connote the potential of creating economic, social and political upheavals, while the indirect consequences are relatable to the risk of communal crisis following increased temperature which forces nomadic herders from the north of the country to migrate (climate refugees) southward deploying open grazing to feed livestock.

This fueled violence between mobile herders and sedentary farmers, displacing people, destroying crops, and preventing cultivation with attendant impact on agricultural output and subsequently prices of food. Conflict has a negative impact on agriculture, economic growth and human development (Aigbokhan, 2007). Perhaps, the conflicts in Nigeria are explicable using the Malthusian survival theory and traceable to the shortage of resources following increased temperature. Consequently, enhancing environmental protection for productivity in the agricultural sector becomes crucial for ensuring sustainable economic development in Nigeria (Imandojemu, 2022). Regrettably, there is a scarcity of literature concerning the influence of temperature increase on agricultural output, particularly focusing on the peculiarities of the Nigerian economy. In Nigeria, we are aware of only few studies which estimate the impact of temperature rise on agricultural output (Agu & Obodoechi, 2021; Amare & Balana, 2023).

This study contributes to the existing scant literature in several ways. Firstly, it incorporates increased temperature as an intermediate input factor into the Dynamic Computable General Equilibrium (DCGE) model. This integration allows for the development of a theoretical framework that can effectively determine the impact of climate change on agricultural output using a general equilibrium model and considering the effects on output, input, and structure. Secondly, in terms of data measurement, a cluster analysis is conducted to categorize different agricultural commodities based on their sub-sector classification in the agricultural value chain. Additionally, the heterogeneity analyses of the dichotomized agricultural commodity are performed to calculate the aforementioned indicators and provide data support for the empirical analysis. Lastly, the paper also considers the analysis of the impact of the temperature shocks on agricultural output from the static (short-term) perspective in the year 2023, followed by an assessment of the dynamic (long-term) effect spanning ten years from 2023 to 2032.

The remaining section of the paper is structured into four parts. Part 2 entails a comprehensive literature review, while Part 3 presents the research methodology. Part 4 focuses on the empirical analysis of the effects of temperature rise on agricultural output. Finally, Part 5 concludes the study and proposes potential solutions.

2. LITERATURE REVIEW

The foundational economic theory presented by Pigou (1920) advocates the possibilities of externalities, including global warming and the rise in temperature caused by carbon emissions. The worst-case scenario predicts a potential increase of 4°C in average temperatures by 2080-2100, as projected by the World Bank (2018). Thus, a number of studies have demonstrated the significant influence of rising temperatures on various aspects of the economy, including production, migrations, local conflicts, and mortality, particularly in developing countries (Dell et al., 2012; Peri & Sasahara, 2019; Bosetti et al., 2021; Burgess et al., 2014; Burke et al., 2015). Burke et al. (2015) discovered a distinct relationship between temperature and productivity, revealing a non-linear pattern. Their result indicates that per capita income growth experiences a significant boost up to an average temperature of approximately 15°C, as determined by a population-weighted analysis (initially estimated at 13°C). This temperature curve implies that countries with colder climates tend to witness an increase in income growth with rising annual temperatures. The result also showed that beyond the threshold of 15°C, higher temperatures start to have a progressively detrimental impact on per capita income growth. However, the available empirical literature on the relation between climate change and agricultural output showed divergent results (Burke & Emerick, 2016; Colmer,2021).

Keane and Neal (2020) investigated the potential consequences of future climate change on the agricultural productivity in the United States. To achieve this, they utilized county-level crop yield and weather data spanning from 1950 to 2015. The researchers introduced a novel technique for panel data estimation known as mean observation OLS (MO-OLS), which effectively accounted for spatial and temporal variations in all regression parameters, including intercepts and slopes. The results of the study provided compelling evidence that the parameters of the production function adapt to local climate conditions. Additionally, it was observed that the sensitivity of crop yield to high temperatures decreased between the years 1950 and 1989. The findings projected that if left unmitigated, the rise in temperature would significantly diminish crop yield. Joshi et al., (2022) revealed that fluctuations in temperature within a year, categorized as anomalies, have a detrimental and significant impact on agricultural production in the United State. Liu et al. (2020) compared temperatures at different times and observed that a 1.5 ◦C increase in global temperature has a positive effect on corn yield, while an increase over 2 ◦C has the opposite effect. Equally, Birthal et al. (2021) analyzed spatial data to examine the effects of climate change on land use and plantation models. They discovered that heat, as a result of climate change, has a significantly negative influence on crop yield. On the other hand, Suresh et al. (2021) conducted a study in Sri Lanka and confirmed the inhibitive impact of climate change on agriculture. Similarly, Nechifor and Winning (2019) and Lu et al. (2019) also found a negative impact. However, they suggested that the adverse effects of temperature rise on agriculture can be mitigated through the implementation of agricultural technology innovation, policy mechanisms, and agricultural infrastructure construction. Furthermore, climate change affects different crops in distinct ways. Liu and Feng (2019) discovered that temperature influences the growth of paddy rice, while long sunshine hours contribute positively to rice yield. Additionally, the spatial distribution of paddies also plays a role in determining the yield.

Other researchers analyzed the influence of temperature change on multiple agricultural products. For instance, Zhang et al. (2018) and Qin et al. (2018), moved a step further to empirically established that climate change affects annual corn yield, with increased temperature and long sunshine hours leading to higher winter wheat and summer corn yields. Chen et al. (2017) developed a one-dimensional linear stepwise regression equation and found that fluctuating rainfall and sunshine have adverse effects on winter wheat yields in Sichuan. They also observed that single-cropped rice yields are vulnerable to increases in temperature. Furthermore, Song et al. (2022) findings indicated that agricultural green total factor productivity is significantly influenced by temperature. In the same line of study, Chandio et al., (2022) examined the effects of climatic and non-climatic factors on Indian agriculture, cereal production, and yield using the autoregressive distributed lag (ARDL) bounds testing approach. The result revealed that temperature adversely affect agricultural output in India. The estimated long-run results further demonstrate that temperature adversely affects cereal production. In a study focusing on essential climate variables relevant to the growth period of corn, Zhu et al. (2019) discovered that high temperatures reduce corn production. Some scholars have also conducted predictive research on the effects of climate change on agriculture, particularly in relation to extreme temperatures. The study conducted by Zhang-qi et al. (2015) revealed a noteworthy finding that crop yields are significantly diminished by extreme temperatures.

In the same vein, Talib et al. (2021) investigated the impact of temperature rise on agricultural production in 32 Sub-Saharan African countries employing the augmented autoregressive distributed lag (ARDL) modeling and panel estimators with multifactor error structures. The study estimated the "dynamic common correlated long-run effects (DCCE)" using both the cross-sectionally augmented distributed lag (CS-DL) approach and the cross-sectionally augmented autoregressive distributed lag (CS-ARDL) approach. The findings of the study indicate that increasing temperatures have a significant negative impact on agricultural growth in Sub-Saharan Africa over the long term. According to the CS-DL approach, a 1°C rise in temperature could potentially lead to a decrease in the agricultural growth rate by as much as 4.2 to 4.7 percentage points. These results highlight the importance of considering the adverse consequences of rising temperatures on agricultural productivity in the region. In their study, Adamu and Negeso (2020) conducted an analysis on the impact of climate change on agricultural output in Ethiopia from 1980 to 2016. They employed the ARDL approach to cointegration to examine both the long-run and short-run effects. The findings from the estimated long-run model indicate that the average temperature plays a significant role in influencing agricultural output, which in turn contributes significantly to the overall GDP of the country. However, the estimated coefficients of the short-run analysis suggest that the average temperature has an insignificant effect on agricultural output. In another similar study, Ajetomobi (2016) examined the impact of extreme weather conditions on crop yield and risk in Nigeria. The study initially employed a conventional method of estimating the effects of climate change by utilizing a quadratic regression model that incorporates weather variables and Growing Degree Days (GDD) based on panel data estimation. Subsequently, they gradually introduce Harmful Degree Days (HDD) and Vapour Pressure Deficit (VPD) into the analysis. The findings of the study reveal a significant and adverse impact on cassava, cotton, and maize crops, as indicated by the strong negative coefficient associated with Harmful Degree Days (HDD). In contrast, Agu & Obodoechi (2021) employed OLS model and Cointegration technique to investigate the influence of temperature fluctuations on agricultural output. The findings revealed a positive relationship between temperature changes and agricultural productivity in Nigeria. Similarly, Adeosun et al., (2021) conducted a study to assess the effects of climate change on agricultural productivity during the period from 1986 to 2015. The study utilized the ordinary least squares (OLS) estimation technique. The findings of the study revealed that temperature had a positive correlation with agricultural output, indicating that higher temperatures were associated with increased productivity. Ajetomobi et al.(2015) investigated the impact of extreme weather conditions on the mean and variance of the yield of 18 food crops in Nigeria spanning a 42-year period from 1971 to 2012. The study focuses on five Agricultural Transformation Agenda (ATA) priority crops at the State level due to limited data availability, covering a period of 22 years from 1991 to 2012. The analytical framework employed in this research involves a stochastic production function. The findings reveal that more than half of the staple crops in Nigeria face a threat to productivity due to an increase in total annual rainfall and extreme temperatures both nationally and across states. Nevertheless, this increase is shown to have positive effects on the productivity of certain crops cultivated in Northern Nigeria. From an economic perspective, extreme temperatures were projected to lead to significant annual losses in value for most crops, with the exception of those primarily grown in Northern Nigeria (specifically in Borno, Yobe, Kaduna, Kano, and Sokoto states) such as millet, melon, and sugarcane.

Despite the numerous studies conducted on the relationship between temperature shocks and agricultural output, only a limited number of researchers have explored this relationship within a Dynamic Computable General Equilibrium Modelling Framework. Furthermore, the majority of these researchers have primarily concentrated on the short-term effects. This particular study aims to investigate both the short and long-term impacts of temperature shocks on agricultural output in Nigeria.

3. METHODOLOGY

3.1 Model Specification

The dynamic computable general equilibrium model (DCGE) utilized in this study is the Standard DCGE model developed by Decaluwé *et al*., (2013). This model focuses on the real sector and considers only relative prices as significant factors. It consists of a set of non-linear equations that describe the optimal behavior of various agents, including accounting identities. The primary objective of this paper is to analyze the impact of temperature rise on agricultural output in Nigeria, and thus, the model incorporates the production process. To ensure a feasible solution for the model, we have chosen specific closure rules. Regarding factor closure, we have assumed a fixed labor supply and allowed for labor to be both unemployed and mobile across different activities. Similarly, we opted for the fixed capital option, where capital is employed and specific to each activity. The key behavioural equations adopted the model is outlined below.

$$VA_{j,t} = v_j XST_{j,t} \quad (1)$$

$$CI_{j,t} = io_j XST_{j,t} \quad (2)$$

$$VA_{j,t} = B_{j,t}^{VA}\left[B_{j,t}^{VA} LDC_{j,t}^{-\rho_j^{VA}} + \left(1 - B_{j,t}^{VA}\right) KDC_{j,t}^{-\rho_j^{VA}}\right]^{-\frac{1}{\rho_j^{VA}}} \quad (3)$$

$$LDC_{j,t} = \left[\frac{B_{j,t}^{VA}}{1-B_{j,t}^{VA}} \frac{RC_{j,t}}{WC_{j,t}}\right]^{\sigma_j^{VA}} KDC_{j,t} --- (4)$$

$$DI_{i,j,t} = aij_{i,j,t} CI_{j,t} ----(5)$$

Where:

$VA_{j,t}$ is value added of industry j;

$B_{j,t}^{VA}$ is total Factor Productivity of industry j;

$LDC_{j,t}$ composite demand for labour of industry j;

$KDC_{j,t}$ composite demand for capital of industry j.

$XST_{j,t}$: Total aggregate output of industry *j*

io j : Coefficient (Leontief – intermediate consumption)

v j : Coefficient (Leontief – value added)

DIi, j : Intermediate consumption of commodity i by industry j

$CI_{j,t}$: Total intermediate consumption of industry *j*

3.2. Data

The calibration process of the model involves the utilization of the 2019 Social Accounting Matrix (SAM) for Nigeria. The construction of the 2019 Nigeria SAM was carried out by Equilibria Consult; an economic consulting firm domiciled in the University of Ibadan. The 2019 Nigeria Social Accounting Matrix (SAM) was obtained from a range of reliable sources and publications, such as the National Bureau of Statistics, Central Bank of Nigeria, Federal Inland Revenue Services (FIRS), and World Integrated Trade Solutions (Beyene et al., 2022). By assuming that the initial data reflects an economy progressing along a steady-state growth trajectory, the parameters of the model are adjusted to ensure that it generates a path that commences from a point mirroring the observed benchmark data set, without taking into account any expected future temperature shocks. This dynamic baseline path serves as the reference point for comparison when evaluating the temperature change scenarios explored in the subsequent sections. In the Social Accounting Matrix (SAM), economic activity is captured by recording incomes on the rows and expenditures on the columns (Nwafor et al., 2010). However, it is important to acknowledge the limitations of the constructed SAM. One such limitation is the assumption that the production structure of the economy remains unchanged from 2019.

3.3 Scenarios Simulation

The central issue is how to incorporate agricultural output shocks resulting from temperature change into the CGE model. In available literature, two pathways exist in modelling the consequences of temperature rise on agricultural production (Yalew, 2020). Temperature rise is either modelled as an exogenous change in technology that alters land productivity (Bosello et al., 2013), or total factor productivity (Wiebelt et al., 2015). This study adopts the latter approach, as the policy implications of land productivity changes remain a black-box. Therefore, a direct method for incorporating these progressions entails diminishing the scale parameter ($B_{j,t}^{VA}$) in the CES production function for the value added of the specific sector (in this instance, the agricultural sector) from its value in the business-as-usual (BAU) scenario.

The business-as-usual (BAU) scenario presents the data as at 2019, which is the base year. Hence this scenario is the hypothetical steady-state equilibrium growth path in the absence of temperature shock. The baseline scenario serves as the reference point for evaluating any fluctuations or sudden shifts in temperature. Another situation involves a situation in which a simulation is conducted where a change in temperature (temperature shock) is introduced and the effect on agricultural output is examined. The simulation introduced a change into the model [that is a 15% temperature increase, equivalent to one standard deviation shock, which results in a reduction of 5.22[1]% in total productivity as shown by Amare & Balana (2023)]. The consequential effect of this 5.22% reduction in total productivity on agricultural output is therefore presented in Table 1 and 2.

4. RESULTS AND DISCUSSION

The CGE model was employed to examine the effect of a temperature shock on agricultural output and the estimation was conducted for both the static (short-term) period, that is year 2023 and the dynamic (long-term) period spanning ten years from 2023 to 2032.

4.1 Short-Term Effect of a Change in Temperature on Agricultural Output

The first step is to consider the simulation result in Table 4.4. The result shows that temperature rise influences agricultural output in the short term. In the short term, a 15% temperature rise will cause a 3.38%, 261%, 3.48% and 4.32% decrease in crop output, livestock production, forest stock and fish production, respectively when compared to the baseline scenario of 2019 in the short run. If temperature rises by 15%, the aggregate agricultural output which is the weighted sum of changes in crop yield (-3.38), livestock (-2.61), forest product (-3.48), and fish production (-4.32) will decline by 3.45% in the short term. The result highlights the sensitivity of the Nigerian agricultural sector to rising temperatures. Moreover, the result confirms that a rise in temperature results in an agricultural output gap. The result could be explained by the fact that high temperature, which results in uncomfortable heat levels is detrimental to the optimal growth of crops, animals (livestock and fish) and forest products. High levels of heat cause dehydration, which could lead to the loss of farm products. In addition, productive factors in the agricultural sector especially labour could become discouraged and move to less climate-sensitive sectors. The result is similar to Agu & Obodoechi (2021) and Chandio et al., (2022). The result is however contrary to Adamu and Negeso (2020), which showed that a rise in temperature leads to a short-term increase in agricultural output.

Table 1: Simulation Results of the Effect of a Change in Temperature on Agricultural Output (Short term)

S/N	Variable	2019 Base Year Value (N'Million)	*SIM1*
1	***CPN***	37,621,864.76	-3.38
2	***LSK***	6,046,291.26	-2.61
3	***FTY***	376,490.78	-3.48
4	***FHY***	2,039,263.37	-4.32
5	***Agg. Agricultural Output***	46,083,910.17	-3.45

Source: Author's Computation based on simulation results from GAMS
Note: Values in SIM1 represent percentage changes from 2019 reference scenario T=Time period (2023); Agg=Aggregate CPN: Crop, LSK: Livestock, FTY: Forestry, FHY: Fishery

[1] See Amare & *Balana* (2023) for clarity on estimates used for temperature shocks.

4.2 Long-Term Effects of a Change in Temperature on Agricultural Output

In the long term, an increase in temperature is projected to result in a reduction in agricultural production. The result indicates that a 15% temperature increase will cause crop output, livestock production, forest stock and fish production to decline by 3.41%, 2.72%, 3.60% and 4.45% respectively when compared to the baseline scenario of 2019. The severity of this impact has been found to increase as temperature intensifies in the long run. Specifically, a 15% temperature increase will cause aggregate agricultural output, which is the weighted sum of changes in crop yield (-3.41%), livestock (-2.72%), forestry (-3.60%), and fish production (-4.51%), to decline by 3.56%. This result is a clear indication that temperature rise accentuates an agricultural output gap in the long run. It is commonly believed that farmers can counteract climate variability due to the variability of all production inputs in the long run. The results demonstrate that increased temperature had a negative impact on agricultural production in the long run despite the possibility of reallocating production inputs to counteract their impact. This is possible when there are no intentional efforts to counter the negative implications of high temperature in terms of heat and dehydration, which could reduce crop yields and the number of surviving livestock and ultimately reduce agricultural output. The result is similar to Adamu and Negeso (2020), Talib et al. (2021), and Chandio et al. (2022), which found that an increase in temperature led to a decrease in agricultural output in the long term. Temperature shock was also found to significantly affect the level of agricultural productivity and production, which are usually substantial sources of household income in developing nations (Dell et al., 2008). The results of the study support the theory of food availability decline (FAD), which suggests that reduction in food supply per person is often caused by different climatic factors such as temperature increase, heightened precipitation, droughts, floods, and pest infestations (Sen, 1982). This theory was also empirically corroborated by Milà-Villarroel et al. (2015) and Oyelami (2023).

Table 2: Simulation Results of the Effect of a Change in Temperature on Agricultural Output (Long term)

T	CPN		LSK		FTY		FHY	
	2019 Base Year Values N'Million	SIM1	2019 Base Year Values N'Million	SIM 1	2019 Base Year Values N'Million	SIM1	2019 Base Year Values N'Million	SIM1
1	37,621,864.76	-3.38	6,046,291.26	-2.61	376,490.78	-3.48	2,039,263.37	-4.32
2	38,750,520.71	-3.38	6,227,680.00	-2.63	387,785.51	-3.51	2,100,441.27	-4.35
3	39,913,036.33	-3.39	6,414,510.40	-2.66	399,419.07	-3.54	2,163,454.51	-4.38
4	41,110,427.42	-3.40	6,606,945.71	-2.69	411,401.64	-3.57	2,228,358.14	-4.41
5	42,343,740.24	-3.40	6,805,154.08	-2.71	423,743.69	-3.59	2,295,208.89	-4.44
6	43,614,052.45	-3.41	7,009,308.71	-2.73	436,456.00	-3.62	2,364,065.16	-4.47

Source: Author's Computation based on simulation results from GAMS

7	44,922,474.02	-3.42	7,219,587.97	-2.75	449,549.68	-3.64	2,434,987.11	-4.50
8	46,270,148.24	-3.43	7,436,175.61	-2.78	463,036.17	-3.67	2,508,036.72	-4.53
9	47,658,252.69	-3.44	7,659,260.87	-2.80	476,927.26	-3.69	2,583,277.82	-4.55
10	49,088,000.27	-3.44	7,889,038.70	-2.82	491,235.08	-3.71	2,660,776.16	-4.58
Ave.	43,129,251.71	-3.41	6,931,395.33	-2.72	431,604.49	-3.60	2,337,786.92	-4.45

Note: Values in SIM1 represent percentage changes from 2019 reference scenario T=Time period (from 2023-2032, with 2023 being the base-year); Ave=Average CPN: Crop, LSK: Livestock, FTY: Forestry, FHY: Fishery

5. CONCLUSIONS AND RECOMMENDATIONS

Nigeria is situated in a region that is highly susceptible to temperature elevation, thereby exerting a profound influence on the agricultural sector within the nation. By gauging agricultural productivity through the temperature impact factor, we can enhance our comprehension of the enduring consequences of temperature rise on Nigeria's agriculture. Furthermore, conducting a comprehensive examination of the ramifications of temperature elevation on agricultural output using the Dynamic Computable General Equilibrium model will enable stakeholders to adopt requisite measures to surmount the long-term challenges engendered by temperature rise. Empirical findings unequivocally demonstrate an upward trend in temperature, which detrimentally affects the agricultural output of the country in both the short and long run.

Based on these findings, several recommendations can be proposed. Firstly, in order to foster the efficient, environmentally friendly, and sustainable growth of agriculture, it is essential to establish agricultural policies and regulations that specifically address the impacts of rising temperatures. To effectively respond to temperature fluctuations, achieve a low-carbon and eco-friendly agricultural sector, and mitigate carbon emissions, governmental bodies at various levels should offer policy and financial assistance for small-scale irrigation systems instead of relying solely on rainfed agriculture. Secondly, implementing reasonable measures to control temperature rise can enhance agricultural production and development while minimizing the risks posed by extreme weather events. The recent successful convening of COP26 has led to a widespread consensus within the international community regarding the need to control global temperature rise. The conference has agreed to limit global temperature increase to 1.5 ◦C, a decision that will contribute to improving agricultural yields and fostering sustainable agricultural practices. Thus, the government has to increase its attention to translating this laudable template to actionable plans. In order to safeguard the welfare of farmers affected by severe temperature conditions and boost their motivation towards agricultural activities, it is imperative to promote agricultural insurance. To achieve this, the government should enhance its backing and financial aid towards agricultural insurance, while also fostering a conducive market atmosphere for the growth of the agricultural insurance sector. Furthermore, the government should actively encourage experts well-versed in insurance and agricultural practices to engage in agricultural insurance, thereby augmenting their capacity to manage risks and calamities effectively.

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