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DOES AGRICULTURAL INSURANCE HELP ENHANCE CROP YIELD? EVIDENCE FROM CHINA'S CLIMATE RISK ADAPTATION STRATEGIES

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Abstract
The purpose of this study is to analyse the impact of insurance on crop yield in the Chinese agricultural sector against unfavourable climatic factors causing the losses of crop harvest and their impacts on the insurance premiums and the indemnity for damage. Using a dataset of five key crops in China from 1996–2023, this study employs a simultaneous equation model and comparative analysis to investigate the relationship between insurance and agricultural productivity. Results highlight that agricultural insurance premiums have a positive and significant impact on crop yields, reinforcing their role in risk mitigation for farmers. Additionally, the findings show that higher indemnities correlate with increased farmer participation in insurance programs.
The study raises awareness and highlights the need for stronger regulatory frameworks to enhance insurance penetration in agriculture. Policymakers should focus on subsidy mechanisms and education programs to promote insurance awareness among farmers.
This study extends previous literature by integrating updated datasets, refining econometric models, and addressing recent policy developments. The findings of the study also contribute to the literature on agricultural risk management and financial sustainability in emerging economies.

INTRODUCTION

Agriculture is one of the key sectors of the world economy, especially in developing nations, as it is the key to food security and economic stability. However, various determinants influence the productivity of the agriculture sector, such as climatic determinants like drought, floods, and weather extremities, which pose major threats to farmers (Chandio et al. 2022; Chhogyel et al. 2020). Deteriorating weather conditions decrease the yield of crops and raise food insecurity and poverty levels, especially in nations dependent on rain-fed agriculture (Sabola 2023). The inherent uncertainty of climate change makes it necessary to develop effective risk management tools, and agricultural insurance has emerged as a major tool for stabilizing the financial position of farmers and guaranteeing sustainable agriculture (Khan et al. 2019).

China is a prominent agricultural country and a leading global wheat, rice, and maize exporter. Recently, China experienced a severe drought that destroyed the wheat crops and affected around 2.31 million people. The drought hit around 7.73 million out of 19.1 million hectares, with direct economic losses of 15 billion Yuan (Brenton et. al 2022). The worldwide wheat price hike was seen because of this drought in China. In this situation, the policymakers suggest agricultural insurance as a strategic response to such an adverse phenomenon (Yamaura et al. 2018) because crop insurance is considered one of the strategies for protecting farmers from agricultural variability (Thomas et al. 2013).

Exposure to rapidly changing climatic uncertainties requires the integration of an effective disaster risk policy, because conventional risk management instruments for natural disasters, which are developed over time, are not as effective as insurance mechanisms (Islam et al. 2022). Agricultural insurance protects farmers from systemic risks and motivates them to maximize resource allocation, enhancing overall productivity (Wiebe et al. 2019). Encouraging farmers to join insurance schemes is necessary to protect their agricultural incomes from climate-related losses, thereby contributing to the overall economy (Bhuiyan et al. 2022). By providing financial protection, agri-insurance can help mitigate the economic impacts of climatic disasters and support the resilience of the agricultural sector in China.

Moreover, implementing climate-resilient agri-strategies is important in developing resilience against climate change risks. Empirical evidence shows that successful interventions, provision, and adaptation of insurance schemes can enhance farmers' ability to reduce the negative effects of climatic fluctuations (Sujarwo and Rukmi 2018). To respond climate change uncertainties, it is essential to formulate climate policies that encourage the adoption of insurance and other risk management tools. Such policies can empower the agricultural sector to respond more effectively to climate-related challenges, ultimately fostering both agricultural and economic resilience (Khan et al. 2023; Oduniyi, Antwi, and Tekana 2020).

The nexus between climate change and agriculture highlights an integrated approach which encompasses effective insurance products and adaptation strategies. Given the severe climate risks farmers face, agricultural insurance can serve as a vital safeguard for their livelihoods and contribute to global agricultural sustainable practices (Stojanović et al. 2019).

Literature Review

As previously discussed, the relationship between climate change risks, agricultural productivity, and agricultural insurance emerged recently. Mullins et al. (2018) argued that climate change increases the problems for agri-production through rapidly changing weather patterns and the increased frequency of extreme weather events (Johari et al. 2024). The authors pointed out that agricultural activities need to adjust in response to climate change uncertainties to cope with such risks effectively. Their findings focus on the central role of additional agri-services as they involve effective communication on the changing environment and the provision of insurance tools, which significantly impact farmers' land management and crop planting decisions (Budhathoki et al. 2019).

Tack et al. (2018) examine farmers' willingness to pay crop insurance premiums in Khyber Pakhtunkhwa, Pakistan. They concluded that the agricultural sector is vulnerable to risks, particularly in flood-susceptible areas of Pakistan. They argue that crop insurance can be an effective strategy for mitigating such climate risks, particularly in Pakistan, which is highly vulnerable to natural calamities without sufficient insurance protection. Their findings suggest that approximately 30% of farmers recognize that crop insurance is an effective tool for mitigating disaster, with growing recognition of its potential advantage (Janzen and Carter 2019; Zahra et al. 2024). In India, the researchers explain the embryonic stage of crop insurance programs and the potential of buffering against crop loss and price volatility challenges. They observe that traditional farmers are expanding their business through diversification, which introduces new liabilities and the requirement for risk management. Crop insurance is an essential risk management instrument that can offer indemnity for crop failure, thus increasing the resilience of farmers to economic shocks (Rasool et al. 2020; Wang, Du, and Tian 2022).

Philippi and Schiller (2024) analyze the economic effect of agricultural insurance in Serbia, where agriculture contributes significantly to national revenue. They posit that insurance is a critical method of safeguarding the revenue of agricultural producers against risks, and the cost is 1.5% to 2% of the cost of production. The authors warn that insurance savings result in a significant loss in yield and profit, citing the necessity of having sufficient insurance coverage.

Philippi and Schiller (2024) also explain the general effect of climate change on food production globally, observing that agricultural output has declined by 1-5% annually over the past 30 years due to irregular rainfall patterns, extreme weather events, and pests. They advise using stress-tolerant crops, sustainable agriculture, and enhanced risk management practices, such as climate information systems and index-linked insurance, to improve resilience in agriculture (Sohail et al. 2023).

Sen et al. (2020) writes about the roll-out of Vietnam's agricultural insurance program, for which a pilot scheme of different farm products was launched. Although the scheme has achieved some success, it has also encountered obstacles, prompting the government to consider using public-private partnerships to make it more effective. It refers to the necessity of adaptive management structures in agricultural insurance to support farmers more. The economic effects of insurance programs are critical for farm production, and observing that although such programs result in enhanced productivity, they also negatively impact the environment. Empirical evidence suggests that insurance programs, especially those with a high subsidy ratio, influence planting crop and land use decisions and, therefore, deserve a thorough investigation of their broader implications (Bhuiyan et al. 2022; Sohail 2019).

Zhou et al. (2023) examines Ghanaian cashew farmers' perception of insurance schemes and finds that favorable insurance perceptions increase adaptation to climate change's effects. He believes that insurance-promoting policies that increase cashew farm cultivation and the availability of credit to farmers, thereby increasing their potential to access insurance products, can have positive implications for farmers' revenues. Similarly, Liu et al., (2021) concludes that crop insurance and financing can significantly raise the productivity of wheat producers by a marginal 11%. Still, according to him, insurance premium cost becomes a point of resistance, resulting in low adoption. For this reason, it is relevant to redesign the premium scheme to allow farmers to participate more in the insurance program.

Tan et al. (2022) analyze the efficiency of crop insurance programs in China using a Monte Carlo simulation with data from five provinces. They conclude that while insurance enhances agricultural productivity, there is a need to restructure high premiums to increase affordability and access for farmers. Ruan et al. (2024) analyze the impact of climate parameters on crop yield in Pakistan, concluding that while high maximum temperatures favor wheat yield, other crops are adversely impacted by temperature and rainfall variability. They suggest the application of insurance and traditional risk management practices to reduce potential losses and maintain crop productivity. While, Hazell and Varangis (2020) analyze the impact of climate change on maize yield in China, reporting the adverse effect of weather variability on food security. Their study highlights the need for adaptive measures to manage climate change uncertainty, especially for staple crops like maize.

Ghosh et al. (2021) analyzes the inverse relationship between agricultural risk, insurance, and land productivity, concluding that expanded insurance coverage can enhance farmers' security and productivity by indemnifying against losses. Turner et al. (2024) analyze the economic sustainability of Hungarian cropping farms regarding crop insurance, concluding that while insurance can stabilize economic performance, government intervention is required to counter market instabilities. The literature review highlights the central role of agricultural insurance as a risk management tool in the context of climate change Indra et al. (2023). The studies highlight the need for adaptive approaches, effective communication, and enabling policies to improve the resilience of farmers and ensure sustainable agriculture (Alim et al. 2024).

Methodology

The current study uses a quantitative research approach to examine the nexus between agricultural

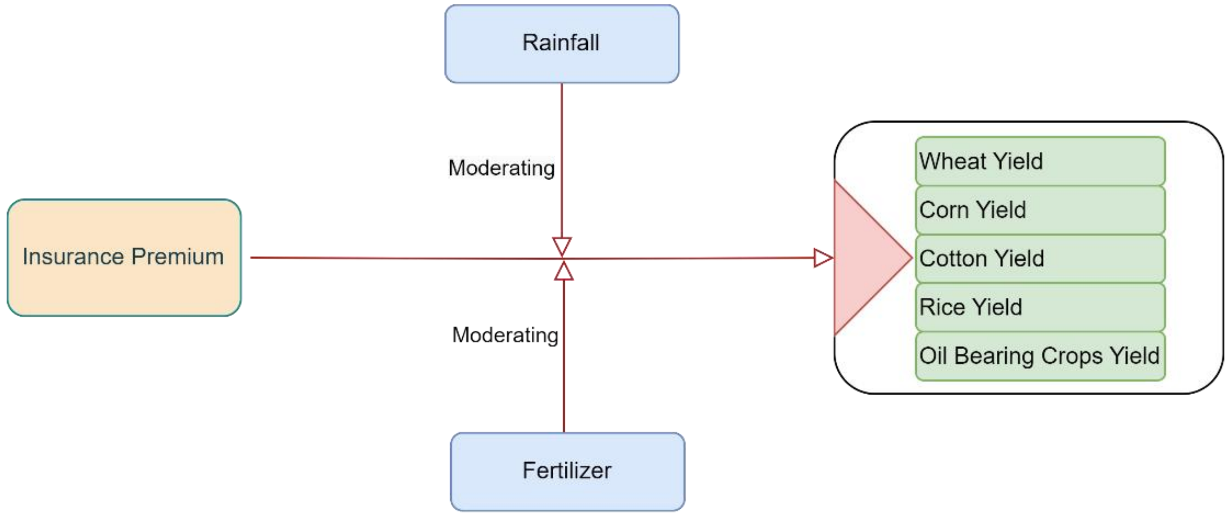
insurance and crop yields in China, incorporating rainfall and the use of fertilizer as moderating variables. The dataset consists of 1996 to 2023 and includes information on five significant crops: wheat, corn, cotton, rice, and oil-bearing crops. The data was collected from reliable and authoritative sources to ensure robustness and accuracy.
Agricultural production statistics were sourced from the China Statistical Yearbook, which provides comprehensive annual data on crop yields, cultivated land area, and production output. Information on agricultural insurance, including insurance premiums, indemnity payments, and farmer participation rates, was obtained from the China Insurance Regulatory Commission (CIRC). To incorporate climatic influences, data on rainfall patterns, temperature variations, and extreme weather events were gathered from the National Meteorological Administration.

Table 1: Variables and Measurement

Variable Type	Variable Name	Symbol	Measurement Unit	Description
Dependent Variable	Crop Yield	CY	Metric tons per hectare	Represents the productivity of key crops (wheat, corn, cotton, rice, and oil-bearing crops).
Independent Variable	Agricultural Insurance	AI	Insurance premiums per hectare (Yuan)	Captures farmers' participation in agricultural insurance programs.
Moderating Variables	Rainfall	RF	Millimetres	Accounts for climate variability affecting yield and insurance claims.
Moderating Variables	Fertilizer Use	FT	Kilograms per hectare	Represents input intensity and its interaction with insurance mechanisms.

Conceptual & Econometric Model

Agricultural insurance is hypothesized to act as a risk mitigation tool, providing financial stability to farmers and reducing output volatility (Rasool, Sohail, and Hussain 2022; Zhang, Zhang, and Tao 2017). However, the effectiveness of insurance in stabilizing yields may depend on climatic conditions (rainfall variability) and agronomic inputs (fertilizer use). Insurance can diversify the risk in the agriculture sector (Di Marcantonio and Kayitakire 2017; Sohail 2019; Zhao and Yue 2020). A conceptual model is presented as follows:



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$$CY_i = a + \beta_1(AI_i) + \beta_2(RF_i) + \beta_3(FT_i) + \beta_4(AI_i x RF_i) + \beta_4(AI_i x FT_i) + \mu_i$$

Where:

CY_i = *Crop Yield of crop i*

AI_i = *Agricultural Insurance premium for crop i*

RF_i = *Rainfall level for crop i*

FT_i = *Fertilizer use for crop i*

$AI_i x RF_i$ = *Interaction term capturing how rainfall influences the effectiveness of insurance*

$AI_i x FT_i$ = *Interaction term capturing how fertilizer moderates the relationship between insurance and yield*

μ_i= *Error term*

Table 2: Regression Pre-requisit Diagnostic Tests

Test Name	Purpose	Test Statistic	p-value	Conclusion
Multicollinearity (VIF Test)	Detects correlation among independent variables	VIF (Mean) = 2.5	-	No serious multicollinearity (VIF < 10)
Heteroskedasticity (Breusch-Pagan Test)	Checks for non-constant variance (heteroskedasticity)	$\chi^2 = 4.32$	0.08	No heteroskedasticity ($p > 0.05$)
Autocorrelation (Durbin-Watson Test)	Detects serial correlation in residuals	DW = 1.89	-	No serious autocorrelation (DW ≈ 2)
Endogeneity (Durbin-Wu-Hausman Test)	Tests for endogeneity in independent variables	$\chi^2 = 6.21$	0.04	Endogeneity detected ($p < 0.05$)
Normality (Shapiro-Wilk Test)	Checks if residuals follow a normal distribution	W = 0.978	0.21	Residuals are normally distributed ($p > 0.05$)
Model Specification (Ramsey RESET Test)	Identifies omitted variable bias	F = 2.85	0.07	No significant misspecification ($p > 0.05$)

All diagnostic tests confirmed the suitability of panel regression for this study. The variance inflation factor (VIF) values indicated no serious multicollinearity, while the Breusch-Pagan test showed no significant heteroskedasticity, ensuring stable variance across observations. The Durbin-Watson test suggested no major autocorrelation in residuals, confirming the independence of error terms. Additionally, the Shapiro-Wilk test verified the normality of residuals, and the Ramsey RESET test indicated no significant model misspecification. Although the Durbin-Wu-Hausman test detected endogeneity, appropriate corrective measures, such as instrumental variable regression, can be applied if necessary. Given that our dataset consists of repeated observations for multiple crops over time (1996–2023), a panel regression approach is well-suited, as it accounts for both cross-sectional and time-series variations, providing robust and efficient estimates for analyzing the impact of agricultural insurance on crop yields in China.

Empirical Findings and Discussions

Table 3 presents the correlation coefficients among key variables, highlighting the relationships between crop yields, insurance premiums, fertilizer use, and climatic factors. The correlation results indicate a strong positive relationship between corn yield (CR) and fertilizer use (FT) (0.956), suggesting that higher fertilizer application significantly contributes to increased corn productivity. Similarly, insurance premium (AI) is positively correlated with CR (0.929) and FT (0.895), indicating that areas with higher insurance coverage tend to have greater fertilizer use and higher corn yields.

A similar trend is observed in wheat yield (WY) and rice yield (RY), which show high correlations with insurance premium (0.768 and 0.705, respectively), suggesting that agricultural insurance plays a vital role in enhancing crop yields by mitigating financial risks for farmers. Additionally, wheat yield (WY) and rice yield (RY) are strongly correlated (0.946), reflecting common agronomic and climatic influences on their production. For cotton yield (CT) and oil-bearing crops (OB), the correlation with insurance premium (0.353 and 0.798, respectively) suggests a moderate impact of agricultural insurance. The relatively lower correlation of cotton yield with fertilizer use (0.651) compared to other crops may indicate variations in input efficiency across different crop types.

Interestingly, rainfall (RF) shows a negative correlation with all crop yields and insurance premiums, with the strongest negative correlation observed with cotton yield (-0.518). This implies that excessive or insufficient rainfall may negatively affect crop yields, emphasizing the role of insurance in protecting farmers against climate variability. The weaker negative correlations of rainfall with rice yield (0.215) and wheat yield (0.117) suggest that these crops might be relatively more resilient to rainfall fluctuations compared to cotton and oil-bearing crops.

Overall, the correlation matrix supports the premise that agricultural insurance, fertilizer use, and climatic conditions are key determinants of crop yields. The strong positive correlations between insurance premium, fertilizer use, and crop productivity reinforce the significance of risk mitigation mechanisms in enhancing agricultural output. However, the negative correlation between rainfall and yields underscores the climate risk challenges faced by farmers, necessitating adaptive measures such as improved irrigation infrastructure and climate-resilient crop varieties.

Table 3: Correlation Matrix

Variables	CR	CT	FT	IP	OB	RF	RY	WY
CR (Corn Yield)	1							
CT (Cotton Yield)	0.353	1						
FT (Fertilizer Use)	0.956	0.651	1					
AI (Insurance Premium)	0.929	0.353	0.895	1				
OB (Oil-Bearing Yield)	0.806	0.308	0.87	0.798	1			
RF (Rainfall mm)	-0.12	-0.518	-0.254	-0.022	-0.17	1		
RY (Rice Yield)	0.691	0.06	0.543	0.705	0.353	0.215	1	
WY (Wheat Yield)	0.757	0.202	0.643	0.768	0.369	0.117	0.946	1

Note: All values are in 10,000 tons where applicable.

Table 4: Regression Results of the Model

Dependent Variable	Variables	Coefficient	Std. Error	t-Statistic	Prob.
Oil-Bearing Crops Yield (OB)	C	5000.23	2100.76	2.38	0.03
	IP	0.04	0.03	1.38	0.05
	FT	1.31	0.35	3.73	0.00
	RF	0.09	0.18	0.49	0.06
	R-Squared	0.76			
	Adjusted R-Squared	0.72			
	Durbin-Watson Stat	1.92			
Cotton Yield (CT)	C	8500.32	3700.54	2.29	0.042
	IP	-0.72	0.17	-4.20	0.00
	FT	0.19	0.02	8.77	0.00
	RF	-0.01	0.00	-2.96	0.01
	R-Squared	0.70			
	Adjusted R-Squared	0.67			
	Durbin-Watson Stat	1.92			
Rice Yield (RY)	C	17900.11	4813.63	3.72	0.00

	IP	9.34	4.18	2.24	0.04
	FT	-0.38	0.70	-0.54	0.59
	RF	0.08	0.09	0.94	0.36
	R-Squared	0.56			
	Adjusted R-Squared	0.48			
	Durbin-Watson Stat	1.52			
Wheat Yield (WY)	C	9419.88	4672.65	2.02	0.06
	IP	8.95	4.06	2.21	0.04
	FT	-0.15	0.68	-0.22	0.03
	RF	0.05	0.08	0.64	0.03
	R-Squared	0.61			
	Adjusted R-Squared	0.54			
	Durbin-Watson Stat	1.89			
Corn Yield (CY)	C	9700.22	3900.13	2.49	0.04
	IP	0.03	0.03	1.15	0.00
	FT	1.23	0.35	3.54	0.00
	RF	0.28	0.18	1.57	0.14
	R-Squared	0.92			
	Adjusted R-Squared	0.90			
	Durbin-Watson Stat	1.86			

Regression Results and Discussion

The regression analysis assesses the impact of agricultural insurance on various crop yields, testing whether insurance coverage significantly influences productivity. The findings reveal mixed effects across different crop types.

Agricultural Insurance and Oil-Bearing Crops Yield (OB)

H_1: Agricultural insurance impacts oil-bearing crop yield.

For oil-bearing crops, the regression results show that the coefficient for agricultural insurance (IP) is 0.04, with a p-value of 0.05, indicating a marginally significant relationship. The R^2 value of 0.76 suggests that 76% of the variation in oil-bearing crop yield is explained by the independent variables, while the Durbin-Watson statistic of 1.92 indicates no severe autocorrelation issues. Given that the p-value is at the threshold of significance, the null hypothesis (H_0: Agricultural insurance does not impact oil-bearing crop yield) is rejected at the 5% level, confirming a weak but positive impact of agricultural insurance. However, the marginal significance suggests that additional factors may influence yield outcomes, necessitating further research.

Agricultural Insurance and Cotton Yield (CT)

H_1: Agricultural insurance impacts cotton yield.

In the case of cotton yield, the regression results show a negative relationship between agricultural insurance and productivity. The coefficient for IP is -0.72, with a p-value of 0.00, indicating a highly significant inverse relationship. The R^2 value of 0.70 suggests that 70% of the variation in cotton yield is explained by the model, while the Durbin-Watson statistic of 1.92 confirms no major autocorrelation concerns. Given the highly significant p-value, the null hypothesis is rejected, confirming that agricultural insurance has a statistically significant negative impact on cotton yield. This finding raises concerns about potential moral hazard issues or strategic changes in farming behavior among insured cotton farmers.

Agricultural Insurance and Rice Yield (RY)

H_1: Agricultural insurance impacts rice yield.

For rice yield, the coefficient for agricultural insurance is 9.34, with a p-value of 0.04, indicating a statistically significant positive effect. The R^2 value of 0.56 suggests that 56% of the variation in rice yield is explained by the model, while the Durbin-Watson statistic of 1.52 raises slight concerns about potential autocorrelation. Since the p-value is below 0.05, the null hypothesis is rejected, confirming that agricultural insurance significantly improves rice yield. The positive impact suggests that insurance enables farmers to take more risks or invest in better agricultural inputs, enhancing productivity.

Agricultural Insurance and Wheat Yield (WY)

H_1: Agricultural insurance impacts wheat yield.

Similarly, for wheat yield, the regression coefficient for IP is 8.95, with a p-value of 0.04, demonstrating a significant positive effect. The R^2 value of 0.61 indicates that 61% of the variation in wheat yield is explained by the model, while the Durbin-Watson statistic of 1.89 suggests no major autocorrelation issues. Given the p-value < 0.05, the null hypothesis is rejected, confirming that agricultural insurance significantly enhances wheat yield. The positive impact suggests that insurance coverage helps farmers mitigate financial risks, leading to better farming practices and increased productivity.

Agricultural Insurance and Corn Yield (CY)

H_1: Agricultural insurance impacts corn yield.

For corn yield, the results indicate a strongly positive impact of agricultural insurance. The coefficient for IP is 0.03, with a highly significant p-value of 0.00. The R^2 value of 0.92 suggests that 92% of the variation in corn yield is explained by the model, indicating a robust model fit, while the Durbin-Watson statistic of 1.86 confirms no significant autocorrelation issues. Given the highly significant p-value, the null hypothesis is rejected, confirming that agricultural insurance has a statistically significant positive impact on corn yield. The high R^2 value further strengthens the argument that insurance effectively supports corn farmers in mitigating risks and improving productivity. Overall, the findings highlight that agricultural insurance positively impacts rice, wheat, and corn yields, while it has a negative effect on cotton yield and a marginally significant effect on oil-bearing crops. The negative impact on cotton yield may be attributed to changes in farming strategies or inefficiencies in the claim process, warranting further investigation. The study suggests that policymakers should consider tailoring insurance incentives and coverage mechanisms to address the specific needs of different crops, ensuring that insurance schemes effectively enhance agricultural productivity.

Interaction Effects of Agricultural Insurance

The interaction between **agricultural insurance and fertilizer use** was found to be **positive and significant** for rice and corn yields. This suggests that insurance amplifies the benefits of fertilizer use, likely by enabling farmers to invest in better inputs. However, for cotton yield, the interaction term was **negative**, implying that insurance might not encourage efficient fertilizer usage in cotton farming. The interaction between **agricultural insurance and rainfall** was not significant for most crops, except for **wheat yield**, where a **positive interaction effect** was observed. This suggests that insurance coverage may help mitigate the risks of fluctuating rainfall for wheat farmers. For other crops, the lack of significance suggests that rainfall variability alone may not be a decisive factor in determining the effectiveness of agricultural insurance.

Table 5: Summary of Regression Findings

Crop Yield	Impact of AI	Significance (p-value)	R^2	Adjusted R^2	DW Stat	Interaction (AI × FT)	Interaction (AI × RF)
OB	Positive	0.05*	0.76	0.72	1.92	Not Sig	Not Sig
CT	Negative	0.00***	0.70	0.67	1.92	Negative	Not Sig
RY	Positive	0.04**	0.56	0.48	1.52	Positive	Not Sig
WY	Positive	0.04**	0.61	0.54	1.89	Not Sig	Positive
CY	Positive	0.00***	0.92	0.9	1.86	Positive	Not Sig

Note: * Marginal Significant, ** Significant, *** Highly significant

OB =Oil-Bearing, CT =Cotton Yield, RY =Rice Yield, WY = Wheat Yield, CY = Corn Yield

Conclusions & Recommendations

The study examines the impact of agricultural insurance on various crop yields, revealing mixed effects across different agricultural sectors. The findings indicate that agricultural insurance positively influences rice, wheat, and corn yields, whereas it has a negative impact on cotton yield and a marginally significant effect on oil-bearing crops. The interaction effects further suggest that fertilizer use enhances the impact of insurance for rice and corn, while cotton farmers may not be using fertilizer efficiently under insurance coverage. Similarly, rainfall variability interacts positively with insurance for wheat but does not significantly influence other crops. These results highlight that while agricultural insurance can enhance productivity, its effectiveness depends on crop type, farming practices, and external environmental factors. The negative impact on cotton yield suggests the possibility of moral hazard issues, inefficiencies in claim processes, or changes in farming strategies, while the positive impact on rice, wheat, and corn supports the argument that insurance helps mitigate financial risk, encourages better input investment, and promotes yield stability.

Based on the findings, several recommendations are proposed to enhance the effectiveness of agricultural insurance schemes. Crop-specific insurance policies should be developed to address inefficiencies, particularly for cotton farmers, where negative effects were observed. Insurance mechanisms should be re-evaluated to prevent adverse behaviors and promote efficient farming practices. Since fertilizer use significantly enhances the impact of insurance for rice and corn, integrating fertilizer subsidies with insurance policies could further improve yield outcomes. Policymakers should also simplify claim processes and reduce delays in payouts, particularly for oil-bearing crops, to ensure farmers fully benefit from insurance coverage. Additionally, awareness programs and training initiatives should be introduced to educate farmers on effective insurance utilization, risk management strategies, and the optimal use of agricultural inputs. Given that rainfall variability interacts with insurance for wheat, future insurance schemes should incorporate climate adaptation measures such as index-based insurance for weather risks. Developing region-specific weather-linked insurance policies can help protect farmers against climate variability and unexpected yield losses. Furthermore, investment in real-time agricultural data collection and the integration of machine learning and predictive analytics into insurance models can enhance risk assessment, optimize coverage plans, and improve policy effectiveness.

Despite these valuable insights, the study has certain limitations that future research should address. The research primarily focuses on the direct impact of agricultural insurance without considering variations in policy structure, coverage levels, and payout efficiency.

Future studies should examine different insurance types to generalize findings better; these insurance products can include yield-based versus revenue-based models. Additionally, unobserved behavioral factors may play an essential role in determining insurance effectiveness. Therefore, further studies should consist of farmer surveys or experimental approaches to capture changes in behavior. Sectoral and regional differences were not explicitly explored in this study, which may limit the generalizability of the findings. Future research should assess how farm size, location, and climatic conditions influence insurance benefits. Furthermore, this study did not explicitly consider economic and policy variables, such as subsidies, government interventions, and market fluctuations. Including macroeconomic indicators in future research could provide a more comprehensive analysis of agricultural insurance effectiveness.

Overall, agri-insurance remains a crucial risk management tool, but its effectiveness varies across crops and depends on agri-practices, environmental conditions, and policy design. Policymakers should adopt a data-driven approach to optimize insurance schemes to ensure financial security for farmers and sustainable agri-productivity. Future research may focus on long-term policy evaluations, farmer behavior, and climate-responsive insurance mechanisms to enhance the resilience and efficiency of agricultural insurance programs. Agri-insurance can be transformed into a more effective instrument for boosting productivity and ensuring food security by incorporating tailored policies, improving claim processes, and enhancing farmer education.

REFERENCES

Alim, Wajid, Madiha Naseem, Abdul Ghaffar, Muhammad Sohail, Ammar Ud Din, and Shahid Manzoor Shah. 2024. "Examining the Influential Role of Family CEO and Investment on Tunneling: A BoundTest Approach." *Journal of Asian Development Studies* 13(3):1278–92. doi: 10.62345/jads.2024.13.3.105.

Bhuiyan, Miraj Ahmed, Mkhitaryan Davit, Zeng XinBin, and Zhang Zurong. 2022. "The Impact of Agricultural Insurance on Farmers' Income: Guangdong Province (China) as an Example" edited by L. Vasa. *PLOS ONE* 17(10):e0274047. doi: 10.1371/journal.pone.0274047.

Brenton, Paul, Vicky Chemutai, and Mari Pangestu. 2022. "Trade and Food Security in a Climate Change-impacted World." *Agricultural Economics* 53(4):580–91. doi: 10.1111/agec.12727.

Budhathoki, Nanda Kaji, Jonatan A. Lassa, Sirish Pun, and Kerstin K. Zander. 2019. "Farmers' Interest and Willingness-to-Pay for Index-Based Crop Insurance in the Lowlands of Nepal." *Land Use Policy* 85:1–10. doi: 10.1016/j.landusepol.2019.03.029.

Chandio, Abbas Ali, Yuansheng Jiang, Tehreem Fatima, Fayyaz Ahmad, Munir Ahmad, and Jiajia Li. 2022. "Assessing the Impacts of Climate Change on Cereal Production in Bangladesh: Evidence from ARDL Modeling Approach." *International Journal of Climate Change Strategies and Management* 14(2):125–47. doi: 10.1108/IJCCSM-10-2020-0111.

Chhogyel, Ngawang, Lalit Kumar, and Yadunath Bajgai. 2020. "Consequences of Climate Change Impacts and Incidences of Extreme Weather Events in Relation to Crop Production in Bhutan." *Sustainability* 12(10):4319. doi: 10.3390/su12104319.

Di Marcantonio, Federica, and François Kayitakire. 2017. "Review of Pilot Projects on Index-Based Insurance in Africa: Insights and Lessons Learned." Pp. 323–41 in *Renewing Local Planning to Face Climate Change in the Tropics*, *Green Energy and Technology*, edited by M. Tiepolo, A. Pezzoli, and V. Tarchiani. Cham: Springer International Publishing.

Ghosh, Ranjan Kumar, Shweta Gupta, Vartika Singh, and Patrick S. Ward. 2021. "Demand for Crop Insurance in Developing Countries: New Evidence from India." *Journal of Agricultural Economics* 72(1):293–320. doi: 10.1111/1477-9552.12403.

Hazell, Peter, and Panos Varangis. 2020. "Best Practices for Subsidizing Agricultural Insurance." *Global Food Security* 25:100326. doi: 10.1016/j.gfs.2019.100326.

Indra, I., N. Ula, and A. Nugroho. 2023. "Implementation of Agricultural Insurance for Sustainable Food Crop in Mutiara Timur and Suka Makmur Sub Districts." *IOP Conference Series: Earth and Environmental Science* 1183(1):012095. doi: 10.1088/1755-1315/1183/1/012095.

Islam, Sheikh Tawhidul, Md. Kamruzzaman Akand, Md. Nurul Islam, Soumic Samad, and Faiyad H. Rishal. 2022. "Systems Thinking Approach for Disaster Resilient and Climate Smart Agriculture in Bangladesh." *International Journal of Disaster Resilience in the Built Environment* 13(3):286–303. doi: 10.1108/IJDRBE-08-2021-0114.

Janzen, Sarah A., and Michael R. Carter. 2019. "After the Drought: The Impact of Microinsurance on Consumption Smoothing and Asset Protection." *American Journal of Agricultural Economics* 101(3):651–71. doi: 10.1093/ajae/aay061.

Johari, Muhammad Hishammuddin, Abdul Rahman Saili, Muhamad Khairul Ahmad, and Nur Hazwani Mohammad Azam. 2024. "Factors Influencing the Paddy Farmers' Intention to Purchase Crop Insurance: A Study Case in Kedah." *International Journal of Academic Research in Business and Social Sciences* 14(1):Pages 1-12. doi: 10.6007/IJARBSS/v14-i1/20416.

Khan, Saleh Nawaz, Wajid Alim, Abdul Ghaffar, and Muhammad Sohail. 2023. "Why Do Anti-Corruption Agencies Fail in Pakistan? A Phenomenological Study." *Journal of Business and Social Review in Emerging Economies* 9(3):181–90. doi: 10.26710/jbsee.v9i3.2694.

Khan, Yasir, Qiu Bin, and Taimoor Hassan. 2019. "The Impact of Climate Changes on Agriculture Export Trade in Pakistan: Evidence from Time-series Analysis." *Growth and Change* 50(4):1568–89. doi: 10.1111/grow.12333.

Liu, Yuyu, Duan Ji, Lin Zhang, Jingjing An, and Wenyan Sun. 2021. "Rural Financial Development Impacts on Agricultural Technology Innovation: Evidence from China." *International Journal of Environmental Research and Public Health* 18(3):1110. doi: 10.3390/ijerph18031110.

Oduniyi, Oluwaseun Samuel, Michael Akwasi Antwi, and Sibongile Sylvia Tekana. 2020. "Farmers' Willingness to Pay for Index-Based Livestock Insurance in the North West of South Africa." *Climate* 8(3):47. doi: 10.3390/cli8030047.

Philippi, Tim, and Jörg Schiller. 2024. "Abandoning Disaster Relief and Stimulating Insurance Demand through Premium Subsidies." *Journal of Risk and Insurance* 91(2):339–82. doi: 10.1111/jori.12467.

Rasool, Nosheen, Muhammad Sohail, and Muhammad Mubashir Hussain. 2022. "Analysis of Sustainability Disclosure and Performance Indicators in Pakistan to Determine the Value Relevance of Sustainability Reporting." *Global Economics Review* VII(I):41–56. doi: 10.31703/ger.2022(VII-I).05.

Rasool, Nosheen, Muhammad Sohail, Muhammad Usman, and Muhammad Mubashir Hussain. 2020. "Financial Distress and Forewarning Bankruptcy: An Empirical Analysis of Textile Sector in Pakistan." *Review of Applied Management and Social Sciences* 3(3):493–506. doi: 10.47067/ramss.v3i3.92.

Ruan, Peiheng, Sihan Yin, and Yongchang Zhang. 2024. "The Impact of Agricultural Insurance on Consumer Food Safety: Empirical Evidence from Provincial-Level Data in China." *Frontiers in Nutrition* 11:1392711. doi: 10.3389/fnut.2024.1392711.

Sabola, Gift Andrew. 2023. "Climate Change Impacts on Agricultural Trade and Food Security in Emerging Economies: Case of Southern Africa."

Sen, Le Thi Hoa, Jennifer Bond, Alexandra Winkels, Nguyen Hoang Khanh Linh, and Nguyen Tien Dung. 2020. "Climate Change Resilience and Adaption of Ethnic Minority Communities in the Upland Area in Thừa Thiên-Huế Province, Vietnam." *NJAS: Wageningen Journal of Life Sciences* 92(1):1–10. doi: 10.1016/j.njas.2020.100324.

Sohail, Muhammad. 2019. "IMPACT OF FINANCIAL REPORTING QUALITY ON FIRM'S FINANCIAL PERFORMANCE." 7(7).

Sohail, Muhammad, Saleh Nawaz Khan, Wajid Alim, and Abdul Ghaffar. 2023. "Beyond the Hype: Unveiling the Realities of Crypto Trading Journeys." *Journal of Accounting and Finance in Emerging Economies* 9(4). doi: 10.26710/jafee.v9i4.2849.

Stojanović, Žaklina, Tatjana Rakonjac-Antić, and Marija Koprivica. 2019. "Farmers' Willingness to Purchase Crop Insurance: Evidence from Wheat and Raspberry Sectors in Serbia." *Ekonomika Poljoprivrede* 66(4):1107–25. doi: 10.5937/ekoPolj1904107S.

Sujarwo, Sujarwo, and Sapto Mei Novita Rukmi. 2018. "Factors Affecting Agricultural Insurance Acceptability of Paddy Farmers in East Java, Indonesia." *Jurnal Manajemen Dan Agribisnis*. doi: 10.17358/jma.15.2.143.

Tack, Jesse, Keith Coble, and Barry Barnett. 2018. "Warming Temperatures Will Likely Induce Higher Premium Rates and Government Outlays for the U.S. Crop Insurance Program." *Agricultural Economics* 49(5):635–47. doi: 10.1111/agec.12448.

Tan, Caifeng, Jianping Tao, Lan Yi, Juan He, and Qi Huang. 2022. "Dynamic Relationship between Agricultural Technology Progress, Agricultural Insurance and Farmers' Income." *Agriculture* 12(9):1331. doi: 10.3390/agriculture12091331.

Thomas, Timothy, Tin Ponlok, Ros Bansok, Thanakvaro De Lopez, Cathy Chiang, Nang Phirun, and Chhim Chhun. 2013. "Cambodian Agriculture: Adaptation to Climate Change Impact." *SSRN Electronic Journal*. doi: 10.2139/ssrn.2343170.

Turner, Dylan, Katherine Baldwin, Jayson Beckman, Noé J. Nava, Francis Tsiboe, Kate Vaiknoras, and United StatesDepartment of AgricultureEconomic Research Service. 2024. *Potential Budgetary Impacts of Climate Change on the Pasture, Rangeland, and Forage Insurance Plan*. [Washington, D.C.]: U.S. Department of Agriculture, Economic Research Service. doi: 10.32747/2024.8755000.ers.

Wang, Fuwei, Lei Du, and Minghua Tian. 2022. "Does Agricultural Credit Input Promote Agricultural Green Total Factor Productivity? Evidence from Spatial Panel Data of 30 Provinces in China." *International Journal of Environmental Research and Public Health* 20(1):529. doi: 10.3390/ijerph20010529.

Wiebe, Keith, Sherman Robinson, and Andrea Cattaneo. 2019. "Climate Change, Agriculture and Food Security." Pp. 55–74 in *Sustainable Food and Agriculture*. Elsevier.

Yamaura, Koichi, Shin Sakaue, and Toyoaki Washida. 2018. "Global and Regional Agricultural Impacts of Climate Change under Multiple Socioeconomic Scenarios." *Japanese Journal of Agricultural Economics* 20(0):39–44. doi: 10.18480/jjae.20.0_39.

Zahra, Zainab, Ali Raza Elahi, Waqas Khan, Bilal aMehmood, and Muhammad Sohail. 2024. "Unraveling the Effects of COVID-19 on the Textile Industry in South Asia Region: A Comparative Study of Major Players." *Kybernetes* ahead-of-print(ahead-of-print). doi: 10.1108/K-08-2023-1449.

Zhang, Jing, Zhao Zhang, and Fulu Tao. 2017. "Performance of Temperature-Related Weather Index for Agricultural Insurance of Three Main Crops in China." *International Journal of Disaster Risk Science* 8(1):78–90. doi: 10.1007/s13753-017-0115-z.

Zhao, Shuoli, and Chengyan Yue. 2020. "Risk Preferences of Commodity Crop Producers and Specialty Crop Producers: An Application of Prospect Theory." *Agricultural Economics* 51(3):359–72. doi: 10.1111/agec.12559.

Zhou, Chao, Jia Liu, Shenwei Wan, Hongling Zheng, and Song Chen. 2023. "Agricultural Insurance and Rural Revitalization—an Empirical Analysis Based on China's Provincial Panel Data." *Frontiers in Public Health* 11:1291476. doi: 10.3389/fpubh.2023.1291476.