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*Original Paper*

# From Risk Transfer to Green Incentives: A Literature Review on the Impact of Policy-Supported Agricultural Insurance on Farmers' Fertilizer Input Decisions

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***Abstract***
*Policy-supported Agricultural Insurance (PAI) profoundly influences farmers' production inputs. Synthesizing empirical evidence from China, this paper identifies a paradigm shift in academic understanding from moral hazard to green incentive effects. Specifically, PAI promotes the reduction of chemical pesticides and the adoption of fertilizer-saving technologies by stabilizing income and acting as a substitute for traditional "self-insurance". Crucially, environmental outcomes are contingent upon* ***product design****: high-protection schemes, such as* ***full-cost*** *and* ***digital insurance****, demonstrate significantly superior green incentives compared to traditional models, which may otherwise perpetuate moral hazard. Consequently, PAI has evolved from a mere risk transfer tool into a strategic policy lever coordinating food security with environmental sustainability. Future reforms should prioritize green product innovation, digital transformation, and elevated protection levels to accelerate agricultural green transition.*
***Keywords***
*Policy-supported Agricultural Insurance, Pesticides and Fertilizers, Risk Transfer, Green Incentives*

## 1. Introduction

Agriculture serves as the cornerstone for safeguarding national food security and promoting farmers' income growth. However, its inherent high risks—particularly natural and market risks—remain the core obstacles constraining stable development. As a central instrument in the modern agricultural risk management framework, Policy-supported Agricultural Insurance (PAI) aims to stabilize agricultural production expectations and guarantee farmers' basic income through risk transfer and loss compensation mechanisms. In recent years, the construction of China's agricultural insurance system has achieved exponential growth, becoming the world's largest agricultural insurance market. Data indicates that in 2024, China's agricultural insurance premium income reached 152.1 billion RMB, providing over 5 trillion RMB in risk protection for 147 million households. This scale implies that the insurance mechanism is deeply embedded in the decision-making chain of hundreds of millions of farmers, making it a pivotal policy fulcrum for leveraging agricultural development.

Concurrently, Chinese agriculture is undergoing a profound green transformation. Driven by the goals of "Carbon Peaking and Carbon Neutrality," promoting sustainable agricultural development and reducing resource consumption and environmental pollution have become core national strategies. However, the excessive reliance on agrochemicals such as fertilizers and pesticides in traditional agricultural practices constitutes a severe challenge. Despite China's active promotion of "reduction and efficiency enhancement" in recent years, the total input of agrochemicals remains immense. In 2024, China's agricultural fertilizer application (pure amount) remained as high as approximately 49.882 million tons. A more critical issue lies in inefficient utilization; although the fertilizer utilization rate for China's three major staple crops rose to 42.6% that same year, this implies that over half of the fertilizer is lost to the environment, becoming a primary source of agricultural non-point source pollution and directly threatening soil health, water quality, and agricultural product safety. Against this backdrop, the complex relationship between PAI—as a financial tool penetrating the farm-level decision-making, and farmers' agrochemical input behaviors has become a focal point for both academia and policymakers.

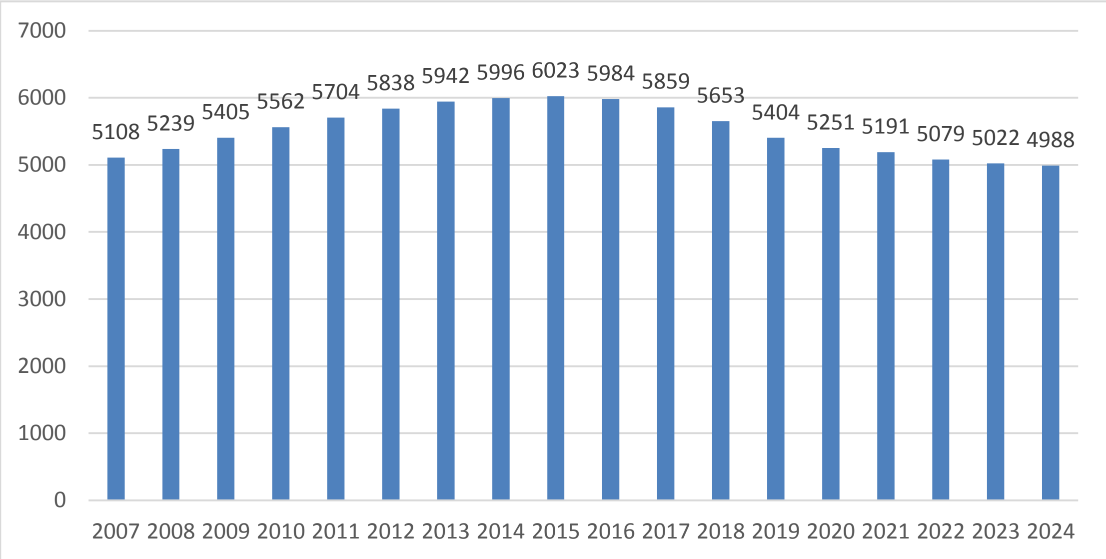


**Figure 1. Trend of Fertilizer Use Application in China (Pure Nutrient), 2007-2024**

This interaction engenders a core behavioral paradox: On one hand, does the "bottom-line" protection provided by insurance trigger moral hazard? That is, after obtaining yield or income guarantees, do farmers reduce their diligence in refined management and tend to continue or intensify extensive production modes characterized by high input and high pollution to maximize yields? On the other hand, can insurance exert a green incentive effect? That is, by mitigating natural and market risks and stabilizing income expectations, does it alleviate credit constraints and risk aversion, thereby encouraging farmers to possess the capacity and confidence to adopt and invest in more efficient, environmentally friendly, but potentially costlier or slower-yielding green production technologies, such as precision fertilization, biological pesticides, and organic fertilizer substitution?

This paradox in conclusions serves as the core entry point of this review. Consequently, the central research question addresses the net impact—positive or negative—of agricultural insurance on Chinese farmers' fertilizer input decisions and the underlying mechanisms. To answer this, this review aims to systematically organize and discriminate among conflicting evidence, focusing on why these discrepancies arise. Specifically, we conduct an in-depth analysis of how different insurance product designs, farmer characteristics, and crop types moderate the ultimate environmental effects of insurance, aiming to provide theoretical grounds and practical implications for the policy design of "Green Insurance."

## 2. Classical Theoretical Analysis and Empirical Evidence

The impact of agricultural insurance on fertilizer input is not a singular pathway but the result of multiple mechanisms acting in concert or even conflict.

### *2.1 Analysis of Basic Mechanisms*

Under the framework of classical expected utility theory, farmers are assumed to be risk-averse rational economic agents. Their decisions regarding fertilizer quantity are primarily based on the equilibrium between expected returns and costs (Zhang et al., 2023). Specifically, fertilizer use possesses a dual attribute: it is both a productive expenditure pursuing yield increases and a means of protecting income against uncertainties such as soil fertility deficiency. Consequently, farmers tend to overuse fertilizer, utilizing it as a form of "self-insurance" (Niu & Chen, 2022). Based on these theories, within the scope of traditional research, the impact of PAI on fertilizer use is analyzed primarily through two pathways.

**(1) Moral Hazard Analysis**

Once farmers secure the safety net of agricultural insurance, their behavioral logic may undergo fundamental changes. If fertilizer application is viewed as a cost for self-risk mitigation, the presence of insurance reduces the marginal benefit of applying fertilizer. Farmers may turn to rely on insurance indemnities to cover potential yield losses, thereby actively reducing fertilizer input (Vincent H. Smith and Barry K. Goodwin, 1996). Multiple empirical studies support this mechanism. For instance, Mishra et al. (2005) found that U.S. winter wheat farmers who purchased revenue insurance spent significantly less on fertilizer. Babcock and Hennessy (1996) reached similar conclusions, finding that fertilizer application rates decline as insurance coverage levels increase. Lu et al. (2023), in analyzing the unintended environmental benefits of insurance on water pollution, listed reduced fertilizer use caused by moral hazard as a key transmission mechanism. Furthermore, Li et al. (2022) termed this reduction "environmentally friendly moral hazard," arguing that after purchasing agricultural insurance, farmers invest less time in field management, which naturally reduces the scale of fertilizer use.

**(2) Adoption of High-Risk New Technologies Reducing Fertilizer Use**

In the absence of agricultural protection, farmers tend to choose low-risk, relatively conservative management styles, abandoning agricultural green technologies that might increase output but entail relatively higher risks. However, with the intervention of PAI, the existence of risk dispersion tools encourages formerly conservative farmers to select novel technologies with relatively higher risks but greater expected returns (Yang Xuemei et al., 2013). In this scenario, fertilizer ceases to be the sole means of maintaining soil fertility, thus reducing the scale of agricultural fertilizer use. Dong et al. (2025) confirmed this theoretical hypothesis using Chinese cases, arguing that insurance empowers farmers to adopt green technologies and reduce fertilizer use by providing "bottom-line" protection, reducing risk aversion, and enhancing opportunities to adopt new technologies. Karlan et al., using

RCT experiments in Kenya, also confirmed that agricultural insurance acts as a safety net mechanism, directly reducing the downside risk faced by farmers, thereby empowering them to make more aggressive, higher-return production decisions—such as tending to purchase high-risk, high-expected-return inputs like improved seeds—consequently reducing fertilizer usage magnitude.

*2.2 Re-examination of Mechanisms: Reconciling the Contradiction between "Pollution Aggravation" and "Green Promotion"*

Classical PAI analysis theories have consistently been used to explore how insurance introduction affects agrochemical use, and studies in the Chinese context are no exception. However, as research deepens, increasing evidence suggests that PAI does not simply reduce fertilizer use. Some China-based studies have found that with the comprehensive rollout of PAI, fertilizer use has actually increased. Niu et al. (2022) provided a more nuanced dynamic perspective for understanding the environmental effects of insurance policies, revealing significant "temporal heterogeneity" in policy outcomes. The study found that in the initial pilot phase of PAI in 2007, while insurance dispersed agricultural production risks, it also induced potential moral hazard—farmers tended to pursue yield maximization by increasing chemical inputs like fertilizer, significantly aggravating agricultural non-point source pollution. However, this negative effect was not static. As the policy entered the comprehensive promotion stage around 2016, with the maturation of insurance mechanisms and the rational correction of farmers' production behaviors, the early negative environmental externalities gradually weakened and vanished. This finding indicates that the impact of insurance on green production possesses non-linear evolutionary characteristics, with long-term policy environmental benefits often outperforming short-term outcomes.

However, distinct from the aforementioned view that insurance aggravates non-point source pollution through "factor accumulation," recent research has captured a fundamental shift in environmental effects as agricultural insurance policy deepens from "cost coverage" to "full-cost coverage," analyzing this dividend from the dual dimensions of "reduction" and "efficiency enhancement." Xiao et al. (2024), based on provincial panel data, first confirmed this significant "reduction effect," finding that the "full-cost insurance" pilot launched in 2018 drove a substantial 21.76% reduction in fertilizer application intensity. It must be noted that this "subtraction" at the input end does not imply negligence in production or insufficient factor input; on the contrary, it is the inevitable result of the "addition" in technology adoption. Sun et al. (2024) provided key mechanistic evidence for this, pointing out that insurance effectively optimized factor allocation by increasing the probability of farmers adopting green technologies such as "Soil Testing and Formula Fertilization (STFF)" (an increase of about 7.2% to 7.7%). Xiao et al. (2024) ultimately confirmed the dialectical unity of this "reduction" and "efficiency enhancement": data showed that while "full-cost insurance" induced a 21.76% decrease in fertilizer intensity, it simultaneously drove a 1.915% increase in fertilizer utilization efficiency, powerfully proving that insurance-induced fertilizer reduction is essentially a result of green efficiency enhancement coordinating ecological protection with production efficiency.

How, can the "pollution aggravation" effect found by Niu et al. (2022) be reconciled with the "green promotion" effect confirmed by Xiao et al. (2024) and Dong et al. (2025)? An in-depth analysis of their research objects reveals that these seemingly contradictory conclusions actually outline a clear trajectory of policy evolution: Niu et al. (2022) focused on the early pilot starting in 2007, characterized by "low protection and traditionalism"; whereas Xiao et al. (2024) and Dong et al. (2025) examined the post-2018 "full-cost insurance (high protection)" and the latest "digital insurance (high efficiency)”. This cross-sectional comparison reveals that “product design” is the critical variable determining the direction of insurance’s environmental externalities. Theoretically, there exists a “risk coverage threshold” for insurance’s impact on green technology adoption. In the early pilot stage, because protection levels were insufficient to cover the uncertainty risks of adopting green technologies like STFF, insurance only functioned as a basic “safety net,” conversely leading farmers to cling to traditional high-fertilizer models due to reduced risk costs, making insurance an “enabler of pollution.” However, with policy upgrades, when protection levels rose to “full-cost” coverage or service mechanisms achieved “high-efficiency” response through digitalization, the safety cushion provided by insurance finally crossed the critical threshold, sufficient to hedge against transformation risks. At this point, the insurance mechanism underwent a qualitative change, shifting from inducing moral hazard to activating innovation effects, successfully transforming into an “enabler of green innovation.” Among them, Dong et al. (2025) provided the most cutting-edge empirical evidence for this “innovation empowerment” mechanism. The study was the first to strictly contrast digital insurance with traditional insurance at the micro-level, finding that the digital insurance’s promotion effect on fertilizer reduction technology was significantly stronger. Its core mechanism lies in digital technologies (e.g., remote sensing, big data) effectively overcoming the high transaction costs and severe information asymmetry faced by traditional insurance in serving smallholders. By providing more precise, timely, and low-cost risk management services, digital insurance effectively alleviates farmers’ risk aversion and credit constraints, thereby significantly enhancing their willingness and capacity to adopt green technologies.

## 3. Heterogeneity Analysis: Region and Crop

### *3.1 Heterogeneity of Risk Areas*

The impact of agricultural insurance on fertilizer input is not spatially uniform but exhibits significant heterogeneity across different risk zones. High-risk areas, characterized by the most volatile agricultural production and the most urgent demand for risk avoidance, demonstrate a stark “double-edged sword” policy effect.

On one hand, in high-risk areas, insurance may induce negative environmental externalities through the “extensive margin” and “moral hazard.” Wu’s (1999) classic study pointed out that income guarantees provided by insurance incentivize farmers to expand production to marginal lands with poor soil or fragile climates (the extensive margin). To maintain yields on these inferior lands, farmers are often forced to significantly increase the application intensity of fertilizers and chemicals. Furthermore, empirical studies by Smith and Goodwin (1996) and Mishra et al. (2005) confirmed that in high-risk scenarios, insurance reduces the expected loss from input failure, thereby triggering moral hazard and prompting farmers to adopt more aggressive, high-fertilizer intensive production models to maximize yields. Niu et al. (2022), based on Chinese cases, also found that early policy-supported insurance aggravated fertilizer pollution more obviously in high-disaster zones.

On the other hand, high-risk areas are also the optimal venues for insurance to exert the “element substitution effect.” According to the theoretical framework established by Babcock and Hennessy (1996), fertilizer in agricultural production possesses dual attributes: it is both a yield-increasing factor and a “self-insurance” tool for farmers to cope with yield volatility. In high-risk areas, farmers often harbor “precautionary motives” for over-fertilization to smooth yield fluctuations. At this juncture, comprehensive agricultural insurance, as a more efficient market-based risk management tool, can directly substitute for the risk-hedging function of fertilizer. Yu and Sumner (2018), focusing on different crops, further supported this, finding that when insurance effectively reduces the background risk of the production system, farmers reduce such precautionary over-fertilization. Xiao et al. (2024) found that full-cost insurance significantly reduced fertilizer application intensity in high-risk areas, whereas the effect was insignificant in low-risk areas. Therefore, whether high-risk areas ultimately exhibit “pollution aggravation” or “green transition” depends on whether the insurance product induces more moral hazard due to bottom-line protection or substitutes more of the originally inefficient fertilizer self-insurance.

These diametrically opposed results profoundly reveal the decisive role of “insurance design” in high-risk environments. High-risk areas act as “amplifiers” of policy effects: in low-risk areas, farmers fertilize primarily for yield increase with secondary risk considerations, so the marginal impact of insurance intervention is limited; but in high-risk areas, risk constraints are the biggest bottleneck hindering green transition. Here, an ill-designed insurance product becomes an enabler of pollution by failing to release this constraint; whereas a well-designed insurance product precisely hits the pain point, leveraging the high risk sensitivity of farmers in these areas to transform it into a powerful impetus for adopting green technologies, thus becoming the most effective lever for green transition.

*3.2 Heterogeneity of Crop and Scale*

As previously mentioned, the environmental effect of agricultural insurance is not a simple monotonic function; its heterogeneous effects across crop types and operational scales exhibit highly intertwined characteristics, remaining an unresolved puzzle in academia. Existing empirical evidence reveals a complex landscape with no uniform solution:

First, crop attributes determine the “baseline logic” of insurance efficacy. For staple crops (wheat, rice), production is characterized by high standardization and mechanization. Studies by Sun et al. (2024) generally show positive green effects, noting that insurance significantly incentivizes farmers to adopt efficiency-enhancing technologies like STFF. This resonates with findings by Ren et al. (2023), suggesting that for low-margin grain crops, the primary function of insurance is to reduce the trial-and-error cost of adopting new technologies, thereby promoting a shift towards “intensive and green” production modes. However, for cash crops (e.g., cotton, fruits, and vegetables), the situation is starkly different. Cha et al. (2023) focused on high-input, high-yield cotton planting and found that the impact of insurance on agrochemical use was more drastic and tended to be negative. This phenomenon is supported by the classic theory of Horowitz and Lichtenberg (1993): for high-value crops, chemical inputs are often viewed as “risk-increasing inputs” (inputs that increase yield but also yield variance); the presence of insurance reduces the potential loss of over-investment, thus inducing farmers to aggressively increase fertilizer use in pursuit of maximum yields.

Second, the scale puzzle is essentially the result of the interaction between the aforementioned crop attributes and “labor constraints”. The debate over whether “large-scale agriculture is greener” or “small-scale agriculture is greener” has persisted for a long time. Zhang et al. (2019) pointed out that as scale expands, agricultural production faces severe rising costs of labor supervision, leading large farmers to substitute expensive manual management with fertilizers. Applying this perspective to the study by Cha et al. (2023) (cotton, strong large-farmer effect), we can clearly see that in labor-intensive cash crop cultivation, insurance provides a “safety net” for large-scale farmers, emboldening them to adopt aggressive substitution strategies of “exchanging fertilizer for labor,” leading to increased fertilizer intensity. Conversely, in staple grain cultivation, due to high mechanization and weak labor substitution demand, scale advantages transform into a “cost-spreading effect” for adopting green technologies, as confirmed by Li et al. (2017).

Therefore, there is no uniform “scale effect” across all crops. The environmental performance of insurance depends entirely on the three-dimensional interaction of “what is grown (crop attributes),” “who is growing it (scale and labor structure),” and “how it is insured (insurance type).” Insurance can be a booster for the green transformation of large grain farmers, or a catalyst for chemical dependency among large cash crop farmers.

## 4. Environmental and Ecological Effects of Policy-supported Agricultural Insurance

Shifting perspective from “inputs” to “ecosystems,” the environmental spillover effects of PAI also demonstrate the coexistence of positive roles and potential risks.

### *4.1 Moral Hazard Aggravation Leading to Negative Externalities*

The “pollution aggravation hypothesis” based on the Moral Hazard perspective occupies the theoretical high ground. This view asserts that insurance mechanisms induce irrational exuberance in fertilizer input and aggravation of non-point source pollution by altering farmers’ risk perception and production boundaries. The microeconomic foundation of this path was laid by Horowitz and Lichtenberg (1993) through their “risk attribute” theory. In the Chinese context, Zhong Funing et al. (2007) confirmed this logic using micro-survey data from the Manas River Basin in Xinjiang. They found that PAI reduced farmers’ sensitivity to natural disaster risks, distorting incentives and prompting farmers—especially commercial farmers pursuing yield maximization—to apply more agrochemicals in the absence of environmental regulations. A more macro-structural explanation comes from Wu’s (1999) “Extensive Margin” theory. Domestic scholars Ma Jiujie et al. (2021) further deepened this mechanism from the perspective of fertilizer non-point source pollution, finding via effect decomposition that while insurance might bring slight emission reductions through technological progress, the induced “Scale Effect” was significantly positive and dominant. This implies that insurance encourages blind expansion of planting scale, which, accompanied by the dilution of refined management capabilities, forces farmers to substitute expensive manual management with excessive chemical inputs, ultimately leading to a dual rise in total fertilizer input and non-point source pollution intensity.

### *4.2 Pollution Reduction via Self-Insurance Substitution and Risk Hedging*

Conversely, the “pollution reduction hypothesis” based on risk management theory emphasizes that a robust insurance market can cut preventative fertilizer input at the source by substituting for inefficient material hedging behaviors. The theoretical cornerstone was established by Babcock and Hennessy (1996), proving that risk-averse farmers harbor “precautionary fertilization” motives in the absence of formal risk transfer mechanisms. Zhang Yuehua et al. (2007) introduced this theory to localized research in China early on, pointing out that PAI provides a more efficient, lower-cost risk transfer tool, mechanically capable of substituting traditional material hedging. Zhang Chi, Lyu Kaiyu, and Cheng Xiaoyu (2019) provided solid micro-empirical support using data from grain farmers in four provinces. Their study confirmed a significant negative correlation between agricultural insurance and agrochemical application. For farmers with high risk aversion, the “risk hedging” function of insurance effectively alleviated anxiety about yield loss, prompting factor configuration to return to rational levels mandated by crop physiology.

### *4.3 Green Technology Empowerment and Total Factor Productivity Enhancement*

Expanding the research horizon, the latest academic frontier moves beyond the simple “input increase/decrease” debate to focus on how insurance empowers technological progress to achieve a “win-win” for economy and ecology—shifting from “reduction” to “efficiency enhancement”. This path emphasizes insurance as an accelerator for green technology adoption. Zhang Xuguang and Chai Zhihui (2024), based on survey data of wheat farmers in four provinces, found that PAI significantly promoted the adoption of green production technologies like STFF and organic fertilizer substitution. The logic is that green transition entails high learning costs and initial yield uncertainty (technological risk); insurance shares the potential trial-and-error costs, increasing farmers’ willingness to pay for new technologies. Furthermore, Yang Tianhang et al. (2025) expanded the perspective to “Agricultural Green Total Factor Productivity.” Their research indicates that agricultural insurance significantly promotes AGTFP with non-linear characteristics. This implies that the environmental dividend of insurance policy is not just a physical reduction in fertilizer (subtraction) but, more importantly, an enhancement in the green output capacity of unit inputs through optimized resource allocation and technological progress (addition). This “efficiency enhancement” mechanism reveals the potential of insurance policies to break the zero-sum game between environmental protection and food security.

## 5. Policy Implications and Research Gaps

### *5.1 Policy Implications*

The design of agricultural insurance policy should shift from mere post-disaster “bottom-line protection” to active green “guidance”. The literature clearly indicates that whether insurance acts as a catalyst for excessive fertilizer input or a regulator for reduction and efficiency depends entirely on the sophistication of institutional design. To block the negative transmission path of “insurance-fertilizer-pollution,” future policy systems must intervene precisely in the key link of fertilizer input across three dimensions: product pricing, technical supervision, and protection depth.

First, promote the “greening” reconstruction of insurance products and establish incentive-constraint mechanisms based on fertilizer application. Traditional insurance contracts often lack constraints on factor inputs during production. Future policies should aim to internalize the environmental costs of fertilizer use by establishing a “fertilizer behavior-insurance benefits” linkage mechanism. Specifically, adopting STFF, organic fertilizer substitution, or committing to fertilizer reduction should be preconditions for obtaining premium discounts or increased indemnity ratios. Through such differentiated institutional arrangements, policy can directly alter the marginal costs and benefits of over-fertilization, guiding farmers at the micro-decision level to abandon extensive models relying on fertilizer accumulation.

Second, accelerate the “digital” transformation of insurance services to achieve precise monitoring and guidance of fertilization behavior. To realize “reduction linkage,” the pain point of information asymmetry—where fertilization behavior is “hard to observe and supervise”—must be resolved. The digital agricultural insurance model integrating remote sensing satellites, IoT, and big data algorithms should be vigorously promoted. This model can precisely retrieve crop growth and fertilization intensity via spectral analysis, making reduction behavior “visible and verifiable,” providing a technical foundation for green differentiated rates. Additionally, digital platforms can push precise fertilization recommendations to farmers, reducing blind over-fertilization due to information scarcity.

Finally, persist in the logic of “high-level protection” substitution to eliminate farmers’ “precautionary fertilization” motives. Theory and evidence repeatedly prove that fertilizer is often treated as “material insurance” against risk. Low-level protection is insufficient to replace this function and may encourage more input by lowering risk costs. Therefore, policy must firmly advance the deepening from “covering material costs” to “full-cost insurance.” Only by providing high-level protection sufficient to cover total production costs and expected returns can the “element substitution effect” of insurance be truly unleashed, giving farmers enough security to cut redundant fertilizers used for “peace of mind,” thereby achieving a fundamental shift from “chemical defense” to “financial defense.”

*5.2 Future Research Directions*

Despite substantial progress in elucidating the “insurance-fertilizer-environment” mechanism, numerous academic gaps remain given the complex reality of China’s agricultural transition. Future research should break through single-dimensional linear analysis and delve into three frontier areas:

Micro-mechanism and Cost-Benefit Assessment of Green Agricultural Insurance. Current discussions on “Green Agricultural Insurance” remain largely conceptual, lacking empirical support from large-scale Chinese data. Future research must answer two core questions: First, “Farmer Response”—what is farmers’ true demand and Willingness to Pay (WTP) for insurance products attached with green conditions? Second, “Relative Efficiency”—does green insurance possess a higher cost-benefit ratio in governing non-point source pollution compared to traditional Agricultural Environmental Payments (AEPs) or fertilizer subsidy reforms? This requires Randomized Controlled Trials (RCTs) or counterfactual frameworks to assess its comparative advantage.

Deconstructing the “Scale Puzzle” under Multi-dimensional Interaction. Existing conclusions on the environmental effects of farm scale are inconclusive, and Mao et al. (2023) imply underlying complexity. Future research must transcend simple linear assumptions to construct a three-dimensional interaction framework of “Crop Attributes (Grain/Cash) × Insurance Design (Full-cost/Digital) × Operational Scale.” It is urgent to clarify: Can full-cost insurance break the “high-input lock-in” of large-scale cash crop farmers? Can digital agricultural insurance overcome the information threshold for smallholders to adopt green technologies? Only by untying this context-dependent knot can precise policy adaptation schemes be provided for different types of operating entities.

Expanding the Research Boundary of Green Technology Adoption. Current literature concentrates heavily on the single indicator of fertilizer reduction, ignoring the potential impact of insurance on the full spectrum of agricultural green transition. Future research should broaden its horizon to a wider “Green Technology Cluster.” Attention should be paid not only to agrochemical reduction but also to the induced mechanisms of insurance on the adoption of key technologies like precision irrigation, conservation tillage, organic fertilizer substitution, and comprehensive straw utilization. Specifically, analysis should focus on how insurance differentially promotes the comprehensive green upgrading of agricultural production modes by mitigating the unique risk attributes of different technologies.

*5.3 Conclusion*

In summary, the historical orientation of China’s agricultural insurance has undergone profound change, escalating from a mere “risk transfer” financial tool to a critical policy lever coordinating the dual strategic goals of “food security” and “environmental friendliness”. Looking ahead, the core logic of policy design must complete the paradigm shift from passive “bottom-line protection” to active “guidance”—that is, relying on the refined reconstruction of “Green Insurance” contracts and the technical empowerment of “Digital Insurance.” This aims to maximize the “innovation empowerment” effect on green production while precisely regulating the environmental costs induced by "negative moral hazard," thereby fundamentally solving the governance puzzle of agricultural non-point source pollution while mitigating natural agricultural risks, providing a solid institutional barrier for the high-quality development of Chinese agriculture.

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**References**

Babcock, B. A., & Hennessy, D. A. (1996). Input demand under yield and revenue insurance. *American Journal of Agricultural Economics*, *78*(2), 416-427. https://doi.org/10.2307/1243713

Cha, J., et al. (2024). Crop insurance, factor allocation, and farmers' income: Evidence from Chinese pear farmers. *Frontiers in Sustainable Food Systems*, *8*, 1378382. https://doi.org/10.3389/fsufs.2024.1378382

Dong, Y., Jia, C., & Su, L. (2025). The impact of digital agricultural insurance on farmers' fertilizer reduction technology adoption: Evidence from China. *China Agricultural Economic Review*. [Advance online publication]. https://doi.org/10.1108/CAER-11-2023-0322

Horowitz, J. K., & Lichtenberg, E. (1993). Insurance, moral hazard, and chemical use in agriculture. *American Journal of Agricultural Economics*, *75*(4), 926-935. https://doi.org/10.2307/1243980

Karlan, D., Osei, R., Osei-Akoto, I., & Udry, C. (2014). Agricultural decisions after relaxing credit and risk constraints. *The Quarterly Journal of Economics*, *129*(2), 597-652. https://doi.org/10.1093/qje/qju002

Li, H., Liu, Y., & Zhao, X. (2017). Estimating the relationship between farm size and fertilizer use efficiency in China. *Journal of Productivity Analysis*, *48*(2), 137-148.

Li, H., Yuan, K., Cao, A., Zhao, X., & Guo, L. (2022). The role of crop insurance in reducing pesticide use: Evidence from rice farmers in China. *Journal of Environmental Management*, *306*, 114456. https://doi.org/10.1016/j.jenvman.2022.114456

Ma, J., Yang, C., Cui, H., & Wang, X. (2021). Environmental effects and influence mechanisms of agricultural insurance: An investigation from the perspective of fertilizer non-point source pollution in China. *Insurance Studies*, (9), 46-61. [In Chinese]

Ministry of Agriculture and Rural Affairs of the People's Republic of China. (2025, January 14). *Utilization rate of chemical fertilizers for three major grain crops steadily improves*. Retrieved from http://www.moa.gov.cn/xw/zwdt/202501/t20250114_6469150.htm [In Chinese]

Mishra, A. K., Nimon, R. W., & El-Osta, H. S. (2005). Is moral hazard good for the environment? Revenue insurance and chemical input use. *Journal of Environmental Management*, *74*(1), 11-20. https://doi.org/10.1016/j.jenvman.2004.08.003

Niu, Z., Yi, F., & Chen, C. (2022). Agricultural insurance and agricultural fertilizer non-point source pollution: Evidence from China's policy-based agricultural insurance pilot. *Sustainability*, *14*(5), 2800. https://doi.org/10.3390/su14052800

Regmi, M., Briggeman, B. C., & Featherstone, A. M. (2022). Effects of crop insurance on farm input use: Evidence from Kansas farm data. *Agricultural and Resource Economics Review*, *51*(2), 361-379. https://doi.org/10.1017/age.2022.5

Smith, V. H., & Goodwin, B. K. (1996). Crop insurance, moral hazard, and agricultural chemical use. *American Journal of Agricultural Economics*, *78*(2), 428-438. https://doi.org/10.2307/1243714

Wu, J. (1999). Crop insurance, acreage decisions, and nonpoint-source pollution. *American Journal of Agricultural Economics*, *81*(2), 305-320. https://doi.org/10.2307/1244583

Xiao, Y., Yang, C., & Zhang, L. (2024). The impact of a full-cost insurance policy on fertilizer reduction and efficiency: The case of China. *Agriculture*, *14*(9), 1598. https://doi.org/10.3390/agriculture14091598

Yang, T., Qi, J., Li, H., et al. (2025). Promotion or inhibition: Research on the impact of agricultural insurance on agricultural green total factor productivity and its mechanism. *Journal of Yunnan Agricultural University (Social Science)*, *19*(5), 136-143. [In Chinese]

Yang, X., Feng, W., Gao, F., et al. (2013). Farmers' risk awareness, insurance cognition, and policy-oriented agricultural insurance: An empirical analysis based on a pilot in Hebei. *Rural Economy*, (9), 5. [In Chinese]

Yu, J., & Sumner, D. A. (2018). Effects of subsidized crop insurance on crop choices. *Agricultural Economics*, *49*(4), 533-545. https://doi.org/10.1111/agec.12434

Zhang, C., Lyu, K., & Cheng, X. (2019). Does agricultural insurance affect farmers' pesticide application? Evidence from grain farmers in 4 provinces. *Journal of China Agricultural University*, *24*(6), 11. [In Chinese]

Zhang, L., Li, X., Yu, J., & Yao, X. (2019). Toward cleaner production: What drives farmers to adopt eco-friendly agricultural production? *Journal of Cleaner Production*, *184*, 550-558. https://doi.org/10.1016/j.jclepro.2018.02.272

Zhang, L., Yang, Y., & Li, X. (2023). Research on the relationship between agricultural insurance participation and chemical input in grain production. *Sustainability*, *15*(4), 3045. https://doi.org/10.3390/su15043045

Zhang, X., & Chai, Z. (2024). Research on the impact of policy-oriented agricultural insurance on farmers' green production: Based on survey data of wheat growers in 4 provinces. *Insurance Studies*, (6). [In Chinese]

Zhang, Y., Shi, Q., & Gu, H. (2007). A theoretical research and empirical analysis on the demand for agricultural insurance. *Journal of Quantitative & Technical Economics*, *24*(4), 12. [In Chinese]

Zhong, F., Ning, M., Xing, L., et al. (2007). Research on the relationship between agricultural insurance and agrochemical application: An empirical analysis of farmers in the Manas River Basin, Xinjiang. *China Economic Quarterly*, (S1), 18. [In Chinese]