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ADVANCES IN SOCIAL HUMANITIES RESEARCH

Determinants of Farmers' Intention to Adopt Premium Insecticides: The Moderating Role of Perceived Harvest Risk Evidence from Rice Farmers in Lamongan, Bojonegoro, and Tuban, Indonesia

Wildan Ramadon*, Liem Bambang Sugiyanto, Fahrul Riza, Bisma Jatmika Tisnasasmita
Universitas Ciputra Surabaya, Indonesia
Email: wramadon@magister.ciputra.ac.id*, l0674@lecturer.ubm.ac.id, fahrul.riza@ciputra.ac.id, bisma.jatmika@ciputra.ac.id

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Abstract

The increasing diversity of insecticide products and farmers' limited ability to assess product performance before application create challenges in selecting premium agricultural inputs. This study aims to examine the relationships between Perceived Efficacy, Brand Image, and Price with Premium Insecticide Adoption Intention among rice farmers, while investigating the moderating role of Harvest Risk Perception in these relationships. This study employed an explanatory quantitative approach with a cross-sectional research design. Data were collected from 300 rice farmers in Lamongan, Bojonegoro, and Tuban Regencies, Indonesia, using a combination of quota and purposive sampling techniques. The collected data were analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM) with SmartPLS software. The findings reveal that Perceived Efficacy and Brand Image have positive and significant associations with Premium Insecticide Adoption Intention, indicating that expected product performance and brand-based evaluations contribute to farmers' adoption decisions. Meanwhile, Price does not show a significant direct association with adoption intention. Furthermore, Harvest Risk Perception does not significantly moderate the relationships between Perceived Efficacy, Brand Image, and Price with Adoption Intention. The findings contribute to agricultural marketing and technology adoption literature by highlighting the importance of functional benefits and brand evaluation in farmers' decision-making processes. Practically, the results suggest that agricultural input providers and extension agents should emphasize product performance evidence, technical information, and reliable brand communication to support informed adoption decisions.

INTRODUCTION

Rice production remains a strategic agricultural sector that contributes significantly to global food security, rural livelihoods, and economic stability. The increasing global population, climate variability, and pressure on agricultural productivity have intensified the need for sustainable crop protection strategies to maintain production stability. According to the Food and Agriculture Organization (FAO), maintaining agricultural productivity requires effective management of crop losses caused by pests, diseases, and environmental challenges. Pest infestation remains one of the major constraints affecting crop yields because it directly reduces production quantity and quality while increasing production costs (Badan Pusat Statistik, 2018; Balai Besar Peramalan Organisme Pengganggu Tumbuhan, 2025; Ternate, 2025). Therefore, farmers' decisions regarding the selection and adoption of agricultural

inputs, particularly pesticides and insecticides, have become an important research issue in agricultural management and technology adoption studies.

Rice farming in developing countries faces complex challenges because farmers must balance productivity improvement, economic limitations, and environmental considerations. In Indonesia, rice production plays an essential role in supporting national food security and farmers' household economies. Crop failure caused by pest and disease attacks can disrupt farmers' income stability and their ability to finance subsequent planting seasons. Previous research by Ismindarto et al. (2024) showed that rice farmers use chemical pesticides as a strategy to reduce crop failure risks caused by pests and diseases, although pesticide application requires proper effectiveness, efficiency, and safety considerations. Thus, farmers' decisions regarding insecticide selection are not merely technical decisions but also involve perceptions, experiences, economic considerations, and risk evaluations.

The increasing diversity of agricultural input products has created additional complexity in farmers' decision-making processes. Data from the Agricultural Data and Information System Center (2025) indicated that Indonesia had 5,378 registered pesticide products by the first period of 2025, with insecticides representing the largest category consisting of 1,886 products. The wide range of active ingredients, brands, efficacy claims, and prices makes it increasingly difficult for farmers to evaluate product quality before actual application. Michelson et al. (2023) emphasized that agricultural input quality is often difficult for farmers to verify at the initial purchasing stage, causing them to rely on previous experiences, recommendations from agricultural retailers, interactions with fellow farmers, and demonstration plot information.

Within this context, premium insecticides have emerged as an alternative agricultural input perceived to provide higher value compared with commonly used generic insecticides. However, the adoption of premium insecticides is not determined solely by product availability but by farmers' perceptions regarding product benefits, costs, and reliability. The concept of premium insecticides in this study refers not to an official regulatory classification but to insecticides perceived by farmers as offering greater value compared with generic products. Farmers generally evaluate these products through several dimensions, including expected effectiveness, brand reputation, and price considerations.

Previous studies have identified several factors influencing agricultural technology adoption and pesticide-related decisions. (Haryono et al., 2025; Hashemi & Damalas, 2011) demonstrated that farmers' perceptions of pesticide efficacy influence pest management decisions because expected product performance affects confidence in agricultural inputs. Similarly, Sari et al. (2024) highlighted that brand image plays an important role in pesticide purchase decisions among rice farmers in Indonesia, particularly when farmers cannot fully verify product quality before use. From a consumer value perspective, (Zeithaml, 1988) Customer Perceived Value framework explains that adoption decisions are shaped by evaluations between expected benefits and perceived sacrifices. In agricultural contexts, perceived efficacy represents expected functional benefits, while price represents economic sacrifice and brand image functions as an evaluative signal.

Risk perception is another important factor that may influence farmers' decisions regarding agricultural inputs. Farmers operate under uncertain production conditions, particularly due to pest attacks, crop losses, and unstable agricultural outcomes. Prospect

Theory proposed by Kahneman and Tversky (1979) explains that individuals tend to demonstrate different decision patterns when facing potential losses. Previous research by Hu et al. (2022) found that pest and disease risk perception affects farmers' intentions to adopt agricultural control technologies. Therefore, harvest risk perception may function as a contextual factor that changes how farmers evaluate product efficacy, brand image, and price when considering premium insecticide adoption.

Although previous studies have examined pesticide adoption, agricultural technology acceptance, and farmers' risk behavior, several research gaps remain. Existing studies have generally investigated efficacy perception, input quality uncertainty, brand image, or risk perception separately. Hashemi and Damalas (2011) focused on pesticide efficacy perception, Michelson et al. (2023) examined agricultural input quality uncertainty, Sari et al. (2024) investigated brand image in pesticide purchase decisions, and Hu et al. (2022) analyzed risk perception in agricultural technology adoption. However, limited studies have integrated these dimensions into a comprehensive model explaining farmers' intention to adopt premium insecticides, particularly among farmers who currently use generic insecticides but have prior exposure to premium insecticide information or experience.

The research gap becomes more significant because agricultural adoption decisions are not always represented by a complete replacement of existing technologies. Farmers may gradually incorporate new agricultural inputs based on specific conditions, such as pest pressure, crop growth stages, or perceived benefits. (Feder et al., 1981) explained that agricultural innovation adoption is not always dichotomous, while Sok et al. (2024) demonstrated that farmers' intentions regarding pesticide use can vary depending on individual characteristics and decision contexts. Therefore, understanding premium insecticide adoption intention requires examining the combination of product evaluation factors and contextual risk conditions rather than focusing only on actual switching behavior.

This study addresses these gaps by developing an integrated model that examines the relationships between Perceived Efficacy, Brand Image, and Price with Premium Insecticide Adoption Intention, while testing Harvest Risk Perception as a moderating variable. The novelty of this research lies in combining customer perceived value perspectives with risk-based decision-making approaches to explain farmers' adoption intentions toward premium agricultural inputs. Furthermore, this study focuses specifically on rice farmers in Lamongan, Bojonegoro, and Tuban Regencies, which represent important rice-producing areas in East Java with relevant pest management challenges. These locations provide an empirical context for understanding how farmers evaluate premium insecticides under agricultural risk conditions.

Based on these considerations, this study aims to analyze the determinants of farmers' intention to adopt premium insecticides by examining the effects of Perceived Efficacy, Brand Image, and Price, as well as evaluating the moderating role of Harvest Risk Perception. Theoretically, this research contributes to the agricultural adoption literature by expanding understanding of how functional benefits, brand-based evaluations, and economic considerations influence farmers' decisions regarding agricultural inputs. Practically, the findings provide insights for agricultural input companies, policymakers, and extension workers in designing strategies that emphasize product performance evidence, reliable information dissemination, and farmer-centered decision support. Through this contribution,

the study is expected to support more informed, efficient, and context-sensitive agricultural input adoption practices.

METHOD

This study uses an explanatory quantitative approach (explanatory research) with a cross-sectional design. This approach is used to test the structural relationship between Efficacy Perception (X1), Brand Image (X2), and Price (X3) with Premium Insecticide Adoption Intention (Y), as well as test the role of Harvest Risk Perception (Z) as a moderation variable. (Sekaran & Bougie, 2016; Sharifzadeh et al., 2018) explained that quantitative research focuses on testing theory through systematic measurement of variables using statistical techniques.

Population, Samples, and Sampling Techniques

The population in this study is rice farmers who are actively cultivating land in Lamongan, Bojonegoro, and Tuban Regencies. The three regions were chosen because they are rice production centers in East Java and have a context of plant pest organism risk relevant to the use of insecticides. The study is focused on rice farmers who use generic insecticides who have had exposure to information or experience of using premium insecticides in the crop protection system. This study uses a non-probability sampling technique because there is no sampling frame available that contains a definitive list of rice farmers using generic insecticides who have had exposure to premium insecticides in the study area. The sampling technique was carried out through a combination of quota sampling and purposive sampling. Quota sampling was used to determine the allocation of respondents in each district based on the proxy area of the rice harvest, while purposive sampling was used to ensure that the selected respondents met the inclusion criteria of the study.

Data Analysis Techniques

Data analysis in this study was carried out using the Partial Least Squares Structural Equation Modeling (PLS-SEM) method with the help of SmartPLS 4.1.1.8 software. PLS-SEM was chosen because the study simultaneously estimated several reflective latent constructs and structural relationships, including the moderation effect. This method is also in accordance with the purpose of the study to explain the variation in Premium Insecticide Adoption Intention through intervariable relationships in the research model (Hair et al., 2021). The analysis stage consists of the evaluation of the measurement model (outer model) and the evaluation of the structural model (inner model). The evaluation of the measurement model was carried out to assess the validity and reliability of the indicators in representing latent constructs, while the evaluation of the structural model was used to evaluate the relationship between variables and the ability to explain the model.

Hypothesis Testing and Moderation Effects

Hypothesis testing was carried out through a bootstrapping procedure with 5,000 subsamples to obtain standard errors, t-statistical values, p-values, and confidence intervals for path coefficient estimation. The test was used to evaluate the significance of the direct relationship and moderation effect in the research model.

The moderation effect was analyzed using the Two-Stage Approach. In the first stage, the main effect model was estimated to obtain a latent variable score from the predictor construct and Harvest Risk Perception as the moderator. In the second stage, the score was used to form an interaction construct which was then estimated in the structural model. The

interactions tested included Efficacy Perception × Harvest Risk Perception, Brand Image × Harvest Risk Perception, and Price × Harvest Risk Perception.

The level of significance of the study was set at 5% ($\alpha = 0.05$). Because the research hypothesis has a relationship direction that has been theoretically formulated, the hypothesis is stated to be supported if the path coefficient has a direction that is in accordance with the hypothesis and is significant based on bidirectional testing at the level of 5% (p-value ≤ 0.05), with a 95% confidence interval that does not cross zero. The hypothesis is stated to be unsupported if the coefficient direction does not match the hypothesis or the relationship is not statistically significant.

RESULTS AND DISCUSSION

Structural Model Evaluation and Hypothesis Testing

The evaluation of the structural model was carried out through the examination of collinearity, model explanatory ability, effect size, and significance of path coefficients. Collinearity was evaluated using variance inflation factor (VIF), with values below 3 used as a conservative boundary. All VIF values were in the range of 1,211–2,024 so that no significant collinearity problems were found among the predictors in explaining the Intention of Premium Insecticide Adoption.

Table 1. Inner VIF Test Results

Intervariable Relationships	VIVID
Brand Image → Intention to Adopt Premium Insecticides	2.006
Price → Premium Insecticide Adoption Intention	1.211
Perception of Efficacy → Intention of Premium Insecticide Adoption	1.510
Perception of Harvest Risk → Premium Insecticide Adoption Intention	1.986
Perception of Harvest Risk × Brand Image → Premium Insecticide Adoption Intention	2.024
Perception of Harvest Risk × Price → Intention of Premium Insecticide Adoption	1.315
Perception of Harvest Risk × Perception of Efficacy → Intention of Adoption of Premium Insecticide	1.776

Source: Data processed with SmartPLS, 2026

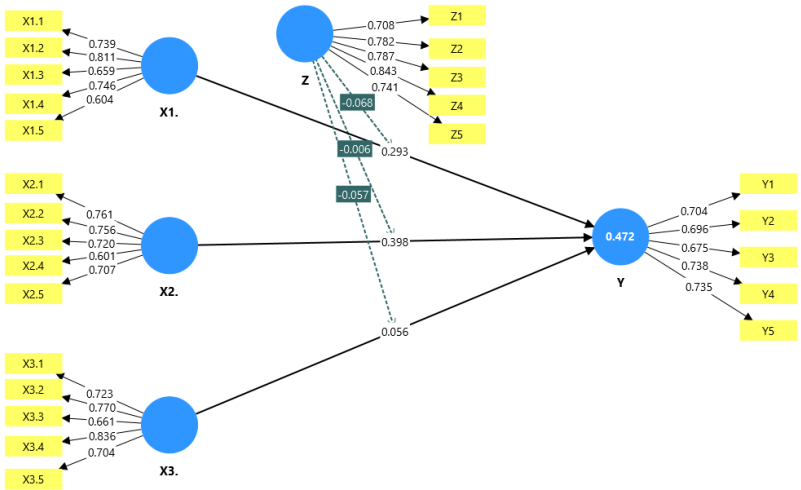


Figure 1 – Inner Model

Source: SmartPLS 4.1.1.8 (2026)

The model yielded an R^2 value of 0.472 and an adjusted R^2 of 0.460. The value showed that the construct in the model explained 47.2% of the variation in Premium Insecticide Adoption Intention, while after taking into account the number of predictors, the proportion of the described variation was 46.0%.

The f^2 effect measure is used to assess the change in R^2 when a predictor is excluded from the model. The f^2 values of 0.02, 0.15, and 0.35 are used as a reference for small, medium, and large effects, respectively, while values below 0.02 indicate a very small contribution. Brand Image has the largest numerical f^2 value in the tested model, which is 0.1496. It is still categorized as a small effect, although it is close to the moderate effect threshold of 0.15. Efficacy Perception has a small effect size of 0.108. Meanwhile, Price and the three interaction constructs have f^2 values of 0.000–0.005, so their relative contribution to R^2 is very small.

Table 2. R^2 and R^2 Adjusted Test Results

Construct endogenous	R^2	R^2 Adjusted
Premium Insecticide Adoption Intention	0.472	0.460

Source: Data processed with SmartPLS, 2026

Significance testing was carried out through a bootstrapping procedure with 5,000 subsamples, bidirectional testing, and a significance level of 5%. The hypothesis is stated to be supported if the direction coefficient is in accordance with the hypothesis formulation and the $p\leq$ value is 0.05, which is equivalent to the absolute value of $t\geq 1.96$. The results of the structural relationship test are presented in Table 12.

Table 3. Hypothesis Testing Results

Structural relationships	b	*t*	*p*	f^2	Verdict
Perception of Efficacy → Intention of Adoption	0.293	3.558	<0.001	0.1080	H1 supported
Brand Image → Adoption Intent	0.398	4.862	<0.001	0.1496	H2 supported
Price → Adoption Intention	0.056	1.188	0.235	0.005	H3 not supported
Perception of Harvest Risk × Perception of Efficacy → Intention of Adoption	−0.068	0.842	0.400	0.0050	H4 not supported
Perception of Harvest Risk × Brand Image → Adoption Intention	−0.006	0.092	0.927	0.0000	H5 not supported
Perception of Harvest Risk × Price → Adoption Intention	−0.057	1.031	0.303	0.0050	H6 not supported

Source: Data processed with SmartPLS, 2026

Tabel 4. Confidence Interval (CI)

Structural relationships	95% CI	Crossing 0?
Perception of Efficacy → Intention of Adoption	0.117 – 0.439	No
Brand Image → Adoption Intent	0.236 – 0.559	No
Price → Adoption Intention	−0.035 – 0.153	Yes
Perception of Harvest Risk × Perception of Efficacy → Intention of Adoption	−0.202 – 0.116	Yes
Perception of Harvest Risk × Brand Image → Adoption Intention	−0.135 – 0.133	Yes
Perception of Harvest Risk × Price → Adoption Intention	−0.157 – 0.063	Yes

Source: Data processed with SmartPLS, 2026

The bootstrapping results showed that Efficacy Perception had a positive and significant coefficient to Premium Insecticide Adoption Intention ($\beta = 0.293$; $t = 3.558$; $p < 0.001$), so H1 was supported. Brand Image also had a positive and significant coefficient ($\beta = 0.398$; $t = 4.862$; $p < 0.001$), so H2 was supported. Numerically, Brand Image had the largest path coefficient and effect size among direct predictors. However, the difference in coefficient magnitude was not used to conclude that the relationship between Brand Image was statistically stronger than Efficacy Perception because the study did not test the differences between the coefficients.

Price has a positive but insignificant coefficient ($\beta = 0.056$; $t = 1.188$; $p = 0.235$). The direction of the coefficient is the opposite of the negative relationship formulated in H3. Thus, H3 is not supported. Since the coefficient is insignificant and has an f^2 of 0.005, the positive direction only indicates the estimated direction in the sample and cannot be interpreted as evidence that the increase in Price increases the Adoption Intention of Premium Insecticides. The 95% confidence interval results show a pattern consistent with significance testing. The confidence intervals on H1 and H2 do not cross zero, while the intervals on H3 as well as the entire effect of the H4–H6 interaction cross zero. The results of the confidence interval are presented in Table 13.

The three interaction coefficients were insignificant and had a very small effect size. The interaction of Harvest Risk Perception with Efficacy Perception resulted in $\beta = -0.068$, $t = 0.842$, and $p = 0.400$, while the interaction of Harvest Risk Perception with Brand Image resulted in $\beta = -0.006$, $t = 0.092$, and $p = 0.927$. Both coefficients show the opposite direction of estimation to the positive moderation direction formulated in H4 and H5. Meanwhile, the interaction of Harvest Risk Perception with Price yielded $\beta = -0.057$, $t = 1.031$, and $p = 0.303$. The coefficient also did not indicate a moderation direction corresponding to H6 which predicted the weakening of the negative relationship between Price and Premium Insecticide Adoption Intention. Since the entire interaction coefficient is not significant, the direction of the estimate is not further interpreted substantively. Thus, H4, H5, and H6 are not supported. Descriptively, Crop Risk Perception tends to be at a high level. The average of the five indicators is around 4.22 and about 80% of respondents have an average Harvest Risk Perception score of at least 4. The pattern shows that the Crop Risk Perception response in the sample is concentrated at a relatively high level.

Overall, the test results showed that H1 and H2 were supported, while H3, H4, H5, and H6 were not supported. Efficacy Perception and Brand Image were significant direct predictors, while Price and the overall interaction effect did not show significant coefficients. These empirical patterns further became the basis for discussion of the role of expected functional benefits, brand-based evaluative cues, Price, and Harvest Risk Perception in the formation of Premium Insecticide Adoption Intentions.

An R^2 value of 0.472 indicates that the model explains 47.2% variation in Premium Insecticide Adoption Intention. The value suggests that the predictive constructs and moderation interactions included in the model capture a significant portion of the variation in Adoption Intention, but do not yet cover the overall variation in farmer decisions. The agricultural technology adoption literature shows that adoption decisions are also related to farmer characteristics as well as resource and access conditions. A meta-analysis of Ruzzante et al. (2021) found that land area, land tenure status, education, access to credit, extension

access, and organizational membership correlated on average with the adoption of various agricultural technologies, with different determinant patterns according to technology type and context. In the context of pesticide use behavior, Sok et al. (2024) also showed that the relationship between behavioral factors and intention is not always uniform between farmers and can differ by age, education, and income dependence on farming. Thus, the R^2 value of this study shows that the model has captured an important layer of adoption decisions centered on product evaluation, while the dimensions of resources, access, and the heterogeneity of farmer profiles have not been directly represented in the model

The Relationship between Efficacy Perception and Premium Insecticide Adoption Intention

The results showed that Efficacy Perception had a positive and significant relationship with Premium Insecticide Adoption Intention ($\beta = 0.293$; $t = 3.558$; $p < 0.001$; $f^2 = 0.108$), so H1 was supported. This relationship showed that farmers' confidence in the product's ability to control difficult pests, provide a rapid and consistent control response, maintain protection, and produce observable changes in the field is related to the increasing Adoption Intention. A relatively small f^2 value indicates that a relatively small f^2 value indicates that the relative contribution of Efficacy Perception to the ability to explain Adoption Intention in the model is relatively small.

In the framework of Customer Perceived Value, Efficacy Perception represents the expected functional benefit. In agroinputs such as insecticides, the actual benefits of the product cannot be fully assessed before application under certain attack conditions. Therefore, farmers form expectations regarding the product's capabilities based on the expected control benefits to be obtained. The observability of the application results is relevant because it allows previously expected benefits to be evaluated through experience in the field.

This interpretation is in line with the concept of relative superiority and observability in the Diffusion of Innovations (Rogers, 2003; Ruzzante et al., 2021). Yan et al. (2026) show that limited information regarding efficacy, dosage, mixing, and application techniques can hinder farmers in obtaining and verifying the expected benefits of biopesticides. Hashemi and Damalas (2011) emphasize the importance of farmers' perceptions of pesticide efficacy in pest management practices, while Sharifzadeh et al. (2018) point out that performance and effectiveness are the criteria group that obtains the highest level of importance in the selection and use of pesticides by farmers. Although the context and variables of the results of the study are not identical to Adoption Intention, the findings support the relevance of expectations to control performance in pesticide evaluation.

Overall, H1 results show that Adoption Intention relates to farmers' expectations of the functional capabilities of premium insecticides. In the context of products whose performance can only be observed after application, the expected control benefits are one of the basis for evaluation before farmers consider incorporating premium products into their crop protection strategies.

The Relationship of Brand Image with Premium Insecticide Adoption Intention

The results of the H2 test showed that Brand Image had a positive and significant relationship with Premium Insecticide Adoption Intention ($\beta = 0.398$; $t = 4.862$; $p < 0.001$; $f^2 = 0.1496$), so H2 was supported. An f^2 value of 0.1496 indicates a small effect size based on the criteria used, although the value is very close to the limit of the medium effect category.

Numerically, Brand Image had the largest direct path coefficient estimate and effect size among the direct predictors tested. However, this study did not test for differences between coefficients so the results were not used to conclude that the Brand Image association was statistically stronger than Efficacy Perception.

The findings suggest that a more positive association with premium insecticide brands is associated with higher Adoption Intentions. In this study, brand imagery is reflected through perceptions of brand quality and consistency, other farmers' experiences, kiosk recommendations, and demonstration plot activities and technical mentoring. When the actual benefits of insecticides cannot be fully verified prior to use, the information associated with the brand can help farmers form an initial assessment of the expected quality and benefits.

This interpretation is in line with (Kahneman & Tversky, 1979; Keller, 1993) (Kahneman & Tversky, 1979; Keller, 1993), who explains that brand image is formed from associations with brands that are stored in the consumer's memory. In conditions when the quality of a product cannot be fully assessed before use, such associations can be the basis for initial evaluation. This perspective is also consistent with (Erdem & Swait, 1998), who explain the role of brand-based information in helping consumers evaluate products when quality cannot be fully ascertained before purchase.

Empirically, the results of this study are also in line with (Dash et al., 2021), who found that brand image has a positive and significant relationship with purchase intention. Although the study was conducted on prospective first-time home buyers in the context of the real estate market, the similarity in the direction of the relationship provides additional empirical support for the relevance of the relationship between brand image and intention. In the context of premium insecticides, the relationship can be understood through the function of brand image as a brand-based evaluative cue when farmers have not been able to fully verify the quality and performance of the product prior to use.

Evidence closer to the context of agroinputs is shown by Sari et al. (2024) and (Suman, 2021; Timmermann, 2015; Wuepper et al., 2021). Sari et al. (2024) show a positive relationship between brand image and pesticide purchase decisions in rice farmers, while Suman (2021) places brand along with other product attributes as one of the considerations in purchasing agroinputs. In the context of this study, experience with a brand, experience of other farmers, kiosk recommendations, and evidence obtained through demonstration plots or technical assistance can form associations with product quality and consistency. These evaluative cues become relevant when decisions regarding the use of premium insecticides need to be made before the actual benefits of the product can be observed directly on the field.

H2 results thus show that Brand Image relates to the farmer's initial assessment of premium insecticides through associations and information attached to the brand. In this research model, the function is different but complements the evaluation of the functional benefits represented by Efficacy Perception. Efficacy Perception is concerned with the expected benefits of product performance, whereas Brand Image helps farmers form an evaluation before the entire actual performance can be verified. Both constructs show a positive and significant relationship with Adoption Intention, but represent different evaluative functions in the research model. Efficacy Perception deals with the expected benefits of product performance, whereas Brand Image helps farmers form an evaluation before the entire actual

performance can be verified. Both constructs show a positive and significant relationship with Adoption Intention, but represent different evaluative functions in the research model.

The Relationship between Price and Premium Insecticide Adoption Intention

Price did not show a significant direct relationship with Premium Insecticide Adoption Intention ($\beta = 0.056$; $t = 1.188$; $p = 0.235$; $f^2 = 0.005$), so H3 was not supported. The direction of the positive coefficient was not given substantive meaning because its value was very small and insignificant. Thus, Price perception had not shown a significant direct relationship with Adoption Intention in the tested model.

In this study, price represents economic sacrifice, not a signal of product quality or prestige. The indicators include the burden on farming capital, the price differencecompared to generic insecticides, caution before purchase, the amount of control cost allocation, and obstacles to regular use. Therefore, the H3 interpretation needs to be placed in the context of economic sacrifice as perceived by farmers.

In the framework of Customer Perceived Value, Price is part of an economic sacrifice that is evaluated alongside the expected benefits. Zeithaml (1988) explains that perceived value is formed through the evaluation between the benefits received and the sacrifices incurred. In the context of agriculture, Liu and Liu (2024) also show that benefits, costs, and risks are part of the evaluation of farmers in technology adoption decisions. Thus, the insignificance of the Price relationship in this study does not mean that economic considerations are irrelevant, but it does show that economic sacrifice does not yet have a significant direct relationship with Adoption Intention in the model tested.

The lack of support for H3 can be understood by considering the difference between Adoption Intention and economic decisions that are closer to actual use. Yue et al. (2023) distinguish between willingness to adopt and willingness to pay, so that openness to the use of a technology is not synonymous with the amount of economic sacrifice that is willing to be incurred. The outcome variables in this study did not measure the number of purchases, the area of application, the frequency of use, the repurchase, and the intensity of actual use. Therefore, the possibility that economic considerations become more prominent at the decision stage closer to the actual purchase or use cannot be concluded from this study.

This interpretation is consistent with the operationalization of Adoption Intention in this study which does not require a full shift away from generic insecticides. Farmers can remain open to try or use premium products gradually or selectively despite acknowledging the economic burden. Therefore, the lack of support for H3 is more appropriately understood as the absence of a significant direct relationship between Price perception and Adoption Intention at the decision stage measured in this study.

Additional empirical context is provided by (Constantine et al., 2020) on smallholder farmers in Kenya. The study identified perceptions of effectiveness, availability, and affordability as the main reasons for low biopesticide use. Farmers rated both chemical pesticides and biopesticides as relatively expensive, but still purchased chemical pesticides because they were considered effective. The findings suggest that affordability remains relevant in pest control decisions, but cost considerations take place alongside evaluations of product effectiveness and availability, rather than as stand-alone factors.

Another relevant interpretation is the possibility of heterogeneity in the weight of economic considerations between farmer profiles. A meta-analysis of Ruzzante et al. (2021)

shows that land area, land tenure status, and access to credit are among the characteristics related to the adoption of agricultural technology, with determinant patterns varying according to the type of technology and context. In the context of Indonesian rice farmers(Ariani et al., 2025) also show the relevance of land tenure status to the structure of input use and technology application. In addition, Sok et al. (2024) show that the relationship between behavioral factors and pesticide use intentions is not always uniform between farmer profiles.

In this study, the relationship between Price and Adoption Intention was estimated at an aggregate level so that the possibility of differences in the weight of economic considerations according to the characteristics of the farming business has not been tested. Therefore, the insignificant price relationship cannot be interpreted as giving the same economic weight to the use of premium insecticides. Price considerations may become more relevant in certain groups of farmers or at a more direct decision stage involving economic sacrifices, such as willingness to pay and actual purchases.

Overall, the H3 results suggest that economic sacrifice has not yet had a significant direct relationship with Premium Insecticide Adoption Intention at an aggregate level. The findings do not suggest that Price is irrelevant in farmer decisions, but that its role has not emerged as a direct predictor at the decision stage and the sample being tested. Price relevance may show different patterns when decisions move towards willingness to pay or actual purchases, as well as when the heterogeneity of economic considerations between farmer profiles is specifically analyzed.

The Role of Crop Risk Perception Moderation on Premium Insecticide Adoption Intention

The entire effect of the Harvest Risk Perception interaction was insignificant. The interaction of Harvest Risk Perception with Efficacy Perception resulted in $\beta = -0.068$; $t = 0.842$; $p = 0.400$; and $f^2 = 0.005$. The interaction of Harvest Risk Perception with Brand Image yielded $\beta = -0.006$; $t = 0.092$; $p = 0.927$; and $f^2 = 0.000$. Meanwhile, the interaction of Harvest Risk Perception with Price resulted in $\beta = -0.057$; $t = 1.031$; $p = 0.303$; and $f^2 = 0.005$. Thus, H4, H5, and H6 were not supported.

The interaction coefficient of Harvest Risk Perception with Efficacy Perception and Brand Image indicates a negative direction, while H4 and H5 predict a strengthening of positive relationships. At H6, the hypothesis predicts that Harvest Risk Perception weakens the negative relationship between Price and Adoption Intention, while the interaction estimates indicate a negative direction. However, because the overall effect of the interaction is insignificant and has a very small effect size, the direction of the coefficient is not interpreted further substantially.

In relation to Prospect Theory, the results of the study have not provided empirical support for the moderation mechanism formulated through Harvest Risk Perception. This does not indicate that harvest risk is irrelevant to farmers, but rather that the level of Harvest Risk Perception in this model has not been proven to change the strength of the relationship between Efficacy Perception, Brand Image, and Price with Adoption Intention.

The descriptive results showed that Crop Risk Perception was at a high level in most respondents. The average of all five indicators was around 4.22 and about 80% of respondents had an average score of at least 4. The pattern showed that concern about harvest risk was a relatively common condition in the sample. However, these conditions have not been proven

to be a distinguishing factor in the relationship between variables. Respondents can equally view crop risk as an important issue, while the strength of the relationship between Efficacy Perception, Brand Image and Price with Adoption Intention does not show a significant change according to the level of Crop Risk Perception in the tested model.

The findings do not indicate that crop risk is irrelevant to farmers. The H4–H6 results only show that Crop Risk Perception has not been shown to change the strength of the relationship between Efficacy Perception, Brand Image, and Price with Adoption Intention. Pannell (1991) showed that the response to risk in pest control decisions can differ according to the source of uncertainty. (Dai & Cheng, 2022) also showed that risk perception does not moderate the entire technology evaluation relationship uniformly. Meanwhile, (Beaman et al., 2021; Chèze et al., 2020) show that the additional risk of production loss due to pests can be an important consideration in farmers' willingness to reduce pesticide use. Thus, the insignificance of the moderation effect in this study cannot be interpreted as the irrelevance of risk in farmers' decisions.

One conceptual possibility is that there is a difference in the level of specification between the Perception of Harvest Risk and the attributes of the product being tested. Perception of Efficacy and Brand Image refer relatively directly to the product or brand being evaluated, while the Perception of Crop Risk in this study captures more common threats in the form of pest infestation, crop damage, loss of income, and uncertainty of outcomes. The literature suggests that farmers' responses to risk may differ according to the source of risk and the context of the decision (Pannell, 1991), while Dai and Cheng (2022) suggest that the role of risk perception moderation may differ between relationships in the adoption model. Therefore, more specific forms of risk to product decisions may show different moderation patterns. These possibilities have not been tested in this study.

Overall, H4–H6 results showed that high Harvest Risk Perception was not followed by a significant change in the strength of the relationship between Efficacy Perception, Brand Image, and Price with Adoption Intention. Crop Risk Perception was a relatively common concern among respondents, but in this model it has not been proven to serve as a differentiating condition between product attributes and Adoption Intention. Two relevant possibilities to explain the pattern are the high concentration of Crop Risk Perception and the difference in specification levels between general crop risk and more specific product attributes. Both possibilities have not yet been established as causes of insignificant moderation effects, but provide a more focused direction for future research.

Research Implications

Theoretically, this study clarifies the application of Customer Perceived Value in the adoption of premium agroinputs. Efficacy Perception and Brand Image were positively and significantly related to Adoption Intention, while Price did not show a significant direct relationship. Harvest Risk Perception also did not moderate the relationship between the three variables, so the risk mechanism in this study has not received empirical support. Managerially, companies can prioritize proving product performance and strengthening Brand Image through field activities and selectively using trial packages by considering benefits and costs.

For agricultural extension workers, the results of the study emphasized the importance of helping farmers evaluate products based on performance and technical suitability, such as OPT goals, product type, timing, dosage, and how to apply. Brand image can be an initial

consideration, but usage decisions need to be supported by evidence and field conditions. Extension workers also need to act as facilitators of technical evaluation and decision-making of farmers, not as a channel for specific brand promotion.

Limitations and Further Research Directions

This study has not considered the heterogeneity of decisions based on the characteristics of farming businesses and the profile of the respondents. Tenure status and land area are especially relevant because they can be related to the structure of input use and technology adoption decisions. In the context of Indonesian rice farmers, Ariani et al. (2025) showed the relevance of land tenure status in the use of inputs and technology applications, while the meta-analysis of Ruzzante et al. (2021) showed that land area, land tenure status, access to credit, education, extension access, and organizational membership were related to the adoption of agricultural technology, with patterns that can differ according to the type of technology and context. In this study, the relationship between Efficacy Perception, Brand Image, Price, and Adoption Intention was estimated in aggregate so that the possibility of differences in relationships according to tenure status and land area, age, farming experience, and resource conditions could not be evaluated. The composition of respondents who were predominantly male also limited the evaluation of possible heterogeneity by gender. The issue of heterogeneity is especially relevant for prices because the weight of economic considerations may differ between farmer profiles. Further research can test this heterogeneity through multigroup analysis or moderation testing of farming characteristics by ensuring adequate group sizes to be compared.

The next limitation relates to the research design and the variables of the results measured. The cross-sectional design measures the entire construct at one time so that the results show relationships between variables, but cannot establish temporal sequences or causal relationships. In addition, this study stops at Adoption Intention and has not observed willingness to pay, purchase decisions, amount or frequency of use, and actual use. The use of quota sampling and purposive sampling on rice farmers in Lamongan, Bojonegoro, and Tuban Regencies also limits the probabilistic generalization of results to the wider farmer population and its application to different regions or commodities. Further research can use longitudinal or panel designs to observe the development of decisions from intention to actual behavior. Subsequent research may also use willingness to pay, purchase decisions, frequency of use, or actual use as outcome variables to evaluate whether relationship patterns, especially those related to price, differ when decisions involve more direct economic consequences.

Another limitation relates to the measurement of Harvest Risk Perception. The score distribution shows concentrations at high levels so that there are relatively fewer observations at the low level of Harvest Risk Perception. These conditions need to be considered in the interpretation of moderation results, but cannot be used to conclude that score concentrations cause insignificant interaction effects. In addition, the Crop Risk Perception in this study captures threats to agricultural yields in general, while Efficacy Perceptions, Brand Image, and Price are more directly related to product evaluation and adoption decisions. Further research can examine more specific forms of risk to the context of the decision, such as risks related to target pests, product performance or quality uncertainty, as well as financial risks directly related to decisions to use premium insecticides. Subsequent studies may also include

cultivation conditions or populations with more diverse levels of Crop Risk Perception to evaluate whether moderation patterns differ when moderator variation is wider.

CONCLUSION

This study concludes that Perceived Efficacy and Brand Image are significant factors associated with Premium Insecticide Adoption Intention among rice farmers in Lamongan, Bojonegoro, and Tuban Regencies. The results indicate that farmers' willingness to adopt premium insecticides is primarily influenced by their expectations regarding product performance and the positive associations attached to the brand. Meanwhile, Price does not show a significant direct relationship with Adoption Intention, indicating that economic considerations have not become the dominant factor at the intention stage measured in this study. Furthermore, Harvest Risk Perception does not significantly moderate the relationships between Perceived Efficacy, Brand Image, and Price with Premium Insecticide Adoption Intention. The research model explains 47.2% of the variation in Premium Insecticide Adoption Intention, demonstrating that product-related evaluations represent important aspects in understanding farmers' adoption decisions, although other factors outside the model may also contribute to this behavior. The findings emphasize that farmers evaluate premium insecticides based on expected functional benefits and brand-based information, while Price and Harvest Risk Perception require further investigation according to different decision contexts.

Future research is recommended to expand the analytical model by incorporating additional variables related to farmer characteristics, resource conditions, and actual adoption behavior. Further studies may examine the role of land ownership status, farm size, education, farming experience, access to credit, extension services, and farmer group participation through multigroup analysis or moderation approaches to identify differences among farmer profiles. In addition, longitudinal research designs are suggested to observe the transition from adoption intention to actual purchasing decisions, willingness to pay, frequency of use, and continued utilization of premium insecticides. Future studies may also develop more specific measurements of risk perception, such as product performance risk, pest-specific risk, quality uncertainty risk, and financial risk, to better understand the role of risk factors in agricultural input adoption decisions.

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All authors contribute to the preparation of research concepts, methodology development, data collection and analysis, manuscript preparation, and manuscript revision. All authors have read and approved the final version of the manuscript.

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