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Understanding Farmers' Intentions in Pesticide Application: Insights from the Theory of Planned Behavior

Nugrahini Susantinah Wisnujati[1*], Suwandi S. Sangadji[2,3], Gancar Candra Premananto[2]

[1] Master's Program in Agribusiness, Faculty of Agriculture, Universitas Wijaya Kusuma Surabaya, Surabaya 60225, Indonesia
[2] Faculty of Economics and Business, Universitas Airlangga, Surabaya 60286, Indonesia
[3] Department of Agribusiness, Universitas Nuku, Tidore 97812, Indonesia

Corresponding Author Email: wisnujatinugrahini@uwks.ac.id

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ABSTRACT

The use of pesticides in the agricultural sector has become a major concern today, especially with the increasing worries about environmental, health, and sustainability impacts. A similar situation is also a focus in Indonesia, known as an agrarian country. Therefore, the objective of this research is to comprehend farmers' intentions in using pesticides through the planned behavior theory perspective. The method employed in this study is quantitative, utilizing a questionnaire as the research instrument. The questionnaire was developed from 25 research indicators using a seven-point Likert scale. This research adopts the "rule of thumb" formula to determine the sample size, recommending that the sample size should be more significant than 10 times the number of manifest variables. Consequently, the resulting sample size is 250 respondents. The data analysis technique in this research employs Structural Equation Modeling (SEM) with the SmartPLS software. The findings of this study highlight a strong relationship between knowledge, attitude, and perceived behavioral control with the intention of pesticide use. In this context, knowledge plays a central role in shaping a positive attitude, while perceived behavioral control is also significant. Although subjective norms do not significantly influence individual intentions to use pesticides, subjective norms remain an essential element in understanding individual behavior because they essentially reflect social pressure and norms accepted by individuals from their environment.

1. INTRODUCTION

Pesticides play a crucial role in modern agricultural practices because they support the achievement of maximum crop productivity and yields. Despite the benefits they provide, their use often sparks controversy due to their potential negative impacts on the environment and human health [1-3]. Easily applicable and yielding rapid results, chemical agents have become the primary choice for farmers to protect their crops. Statistical data notes a significant increase in national pesticide usage, with over 3,200 brands registered and permitted in Indonesia [4]. Therefore, this research is crucial by provide a profound understanding of farmers' intentions in pesticiding usage to develop sustainable agricultural management strategies. Such comprehension can aid in designing more holistic and effective approaches to mitigate the negative impacts of pesticides while ensuring the sustainability of agricultural productivity.

While global pesticide usage trends remained relatively stable in 2020 [5], there exists an empirical gap that needs addressing, particularly in the Asian region, including Indonesia, which is one of the largest contributors to pesticide use [6, 7]. The growing number of registered pesticide types raises serious concerns, highlighting the need for in-depth studies on the psychological factors influencing farmers' intentions in pesticide use. This information gap creates an urgent empirical void this research aims to explore. By delving into farmers' motivations and psychological factors behind pesticide use, this study is expected to provide a more comprehensive and relevant insight. Moreover, the emphasis on the Asian region, especially Indonesia, enriches global understanding of the impacts of pesticide use, allowing for the development of more targeted strategies to enhance sustainable farming practices in this area.

It is important to acknowledge that this research faces a theoretical gap that requires serious attention. Despite the significant proven negative impacts of pesticide use, adequate explanations regarding farmers' behavior in using pesticides are still unavailable. This gap creates room for a more specific approach, and in this context, the application of the Theory of Planned Behavior is considered a crucial step. This theory provides a robust framework for understanding the factors influencing farmers' intentions and behaviors related to pesticide use. Basing the research on this theory, we can gain deeper insights into the psychological, normative, and behavioral control factors shaping farmers' decisions in using pesticides. Therefore, using the Theory of Planned Behavior as a research foundation is expected to fill the existing theoretical gap, providing a deeper understanding of farmers' behavior dynamics in the context of pesticide use and ultimately laying the groundwork for the development of more effective intervention strategies.

The ideas in this research highlight the urgent need for implementation, considering the crucial role of agriculture in the Indonesian economy. The primary focus of this research is on pesticide use, which has the potential to cause harmful impacts on the environment and human health. Understanding psychological factors such as knowledge, attitudes, subjective norms, and perceived behavioral control is at the core of the research objectives. By analyzing these aspects, the research aims to provide in-depth insights into farmers' intentions in using pesticides. Besides having strong theoretical relevance, this research also carries significant practical implications in the development of sustainable pesticide management strategies. With a better understanding of the psychological factors influencing farmers' decisions, efforts to minimize excessive pesticide use can be directed more effectively, positively impacting the overall environment and public health.

Through the integration of Structural Equation Modeling (SEM) and applying the Theory of Planned Behavior, this research aims to delve into the psychological factors influencing farmers' intentions to adopt pesticide use. SEM analysis allows the identification of complex relationships between knowledge, attitudes, subjective norms, and perceived behavioral control variables with the intention to use pesticides. The results of this research are expected to provide a deeper understanding, leading to the formulation of effective and sustainable pesticide management strategies. This understanding forms the basis for formulating agricultural policies that consider psychological aspects, thereby reducing the negative impacts on the environment and human health. With a focus on the modern agricultural context in Indonesia, this research has the potential to make a significant contribution to improving agricultural sustainability and optimizing food security by minimizing the use of potentially harmful pesticides.

Furthermore, this research not only holds theoretical implications but also offers a significant practical contribution. By conducting a detailed analysis of the psychological factors influencing farmers' intentions, this study effectively bridges the gap between theory and practice. The findings of this research can establish a robust foundation for crafting more targeted and effective policies aimed at reducing excessive pesticide use in the agricultural sector. Additionally, gaining a deep understanding of farmers' psychology directly benefits outreach efforts, enabling agricultural service providers to offer more focused guidance to farmers. To achieve these goals, the study formulated several research questions as follows:

RQ 1 Does knowledge have a positive impact on farmers' attitudes toward pesticide use?

RQ 2: Does knowledge have a positive impact on farmers' subjective norms regarding pesticide use?

RQ 3: Does knowledge have a positive impact on farmers' perceived control behavior related to pesticide use?

RQ 4: Do attitudes have a positive impact on the intention to use pesticides?

RQ 5: Does subjective norm have a positive impact on farmers' intention to use pesticides?

RQ 6: Does perceived control behavior have a positive impact on farmers' intention to use pesticides?

2. THEORETICAL BACKGROUND

2.1 Theory of planned behavior

The Theory of Planned Behavior (TPB) is a psychological theory that connects beliefs with behavior. This theory posits that three core components—attitude, subjective norm, and perceived behavioral control—collectively shape an individual's behavioral intentions. In TPB, behavioral intention is considered the closest determinant of human social behavior. Developed by Ajzen [8], this theory aims to enhance the predictive power of the Theory of Reasoned Action (TRA) and account for the role of self-efficacy. TPB has been applied across various human domains, including advertising, health, and sustainability. Attitude toward behavior, subjective norm, and perceived behavioral control are factors influencing behavioral intentions. Attitude toward behavior refers to an individual's evaluation of the behavior in question. Subjective norm pertains to an individual's perception of whether important others in their life support or oppose the behavior. Perceived behavioral control refers to an individual's perception of their ability to perform the behavior. TPB has proven effective in predicting human behavior.

2.2 Knowledge's relationship with attitude in pesticide use

The connection between knowledge and attitude in pesticide use holds significant implications for farmers' behavior, their health, and environmental impact. Intentions based on high knowledge have the potential to predict behavior more accurately than intentions founded on limited knowledge [9]. This is because high knowledge has been proven to shape one's attitude [9, 10]. Therefore, attitudes formed through extensive knowledge are considered more reliable predictors of behavior compared to attitudes based on limited knowledge. Furthermore, attitude evaluation grounded in limited knowledge tends to be less accurate in predicting subsequent behavior and may not reflect individuals' perspectives during action. Conversely, attitudes based on high knowledge are more likely to remain stable between assessment and behavior, creating a stronger connection between attitude and individual actions.

In relation to the aforementioned knowledge and attitudes, when applied in the context of pesticide use, it becomes evident that the relationship between knowledge and attitude, as well as between attitude and pesticide use behavior, is highly significant [11-13]. This relationship is corroborated by research findings from various regions in Indonesia. For instance, a study in West Bandung Regency found that farmers' knowledge and attitudes influence pesticide use behavior [11]. In Bima, educational interventions, such as training programs or workshops, successfully increased farmers' knowledge, attitudes, and practices in pesticide use [12]. Meanwhile, a study in Cepogo affirmed the correlation between farmers' knowledge and attitudes, as well as between practices and pesticide poisoning levels [13].

The emphasis of previous research results underscores the central role of knowledge and attitude in shaping pesticide use behavior, ultimately impacting farmers' health and environmental sustainability. Thus, efforts to enhance knowledge and foster positive attitudes related to pesticide use can be an effective strategy in reducing potential health risks and environmental impacts. Consequently, the following hypotheses can be formulated:

H1: Knowledge positively influences farmers' attitudes towards pesticide usage.

H4: Attitude positively influences the intention to use pesticides.

2.3 The relationship between knowledge and subjective norm in pesticide use

Subjective norm refers to an individual's perception of social pressure that encourages or discourages them from performing a particular action. It is based on the belief that individuals can be influenced by various entities in society, including family members and religious leaders, collectively shaping their behavior [8]. Subjective norm, which pertains to an individual's perception of social pressure influencing specific actions, becomes a crucial factor in understanding pesticide use behavior. In this context, subjective norm is associated with variables such as knowledge about pesticides and moral norms. Knowledge consists of information stored in an individual's memory about a particular phenomenon or issue. This knowledge is not only a personal achievement but can also be taught and conveyed, either verbally or in writing. In innovation diffusion theory, knowledge plays a vital role in relation to the stages of innovation decision-making [14-16], including decisions related to pesticide use.

It is important to note that pesticide use inconsistent with subjective norms can have significant negative impacts on human health and the environment [17-19]. Pesticide poisoning can occur due to non-compliant pesticide use, threatening human organ systems such as the circulatory, respiratory, and integumentary systems, and may even lead to death. Moreover, improper pesticide use can have long-term negative impacts on the environment, jeopardizing the sustainability of future endeavors [20, 21].

Further impacts include issues in plant health, where improper pesticide use in terms of dosage, type, and application timing can affect costs, especially in large-scale cultivation of rice and corn [22, 23]. Organism resistance can also arise due to non-compliant pesticide use. Therefore, farmers can reduce organism resistance in the field if they possess good knowledge, broad insights, and an awareness of subjective norms, thereby minimizing excessive pesticide use [24] that has adverse effects on the surrounding environment. With this explanation, the hypotheses can be formulated as follows:

H2: Knowledge positively influences farmers' subjective norms regarding pesticide usage.

H5: Subjective norms have a positive influence on the intention to use pesticides.

2.4 The relationship between knowledge and perceived control behavior in pesticide use

Perceived behavioral control fundamentally reflects the extent to which an individual feels capable of controlling and implementing a specific behavior, influencing behavior through both direct and indirect intentions [25-28]. In this context, intentions are a measure of the effort an individual is willing to exert to engage in a specific behavior, generally indicating the behavior's likelihood of implementation [8]. For instance, research findings by Tavousi et al. [28] and Karimi and Ataei [29] indicate that perceived behavioral control, associated with how much control one feels over a behavior, can influence behavior through intentions, both directly and indirectly.

In the context of the Planned Behavior theory, factors such as farmer behavior, attitudes, perceived behavioral control, and subjective norms can influence the intention to use pesticides in agriculture [25]. This aligns with Bond et al.'s that Indian farmers have strong behavioral intentions, supportive attitudes, perceived behavioral control, and good subjective norms regarding pesticide use in the next planting season, with attitudes being the most significant factor influencing these intentions. Nevertheless, adequate knowledge about pesticide types, proper dosage, and effective application methods also plays a crucial role in increasing farmers' confidence in managing plant pests and diseases. Sufficient understanding can enhance farmers' self-control, while lack of knowledge or misunderstanding can lead to uncertainty and a lack of self-control, subsequently negatively affecting pesticide use behavior.

In connection with this, Yazdanpanah and Forouzani's [30] research findings show that perceived behavioral control and knowledge about pesticides correlate positively with farmers' intentions to use pesticides, while attitudes correlate negatively with these intentions. Therefore, increasing farmers' knowledge levels through education and training has the potential to enhance their self-control in addressing plant pest challenges, supporting more sustainable and environmentally friendly farming practices. Based on these previous research findings, the following hypotheses are formulated:

H3: Knowledge positively influences farmers' perceived control behavior regarding pesticide use.

H6: The perceived control behavior has a positive influence on the intention to use pesticides.

The literature review and hypothesis development, as explained above, are further illustrated in the following research framework.

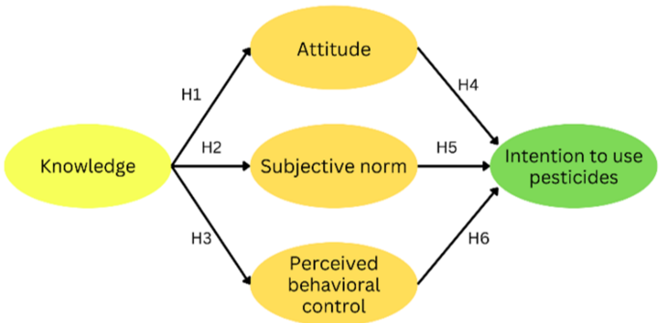

Figure 1. Research framework

Figure 1 above depicts the assumed correlation between knowledge, attitude, subjective norm, perceived behavioral control, and intention to use pesticides. Based on previous literature reviews, we predict that all components of the theory of planned behavior, as mentioned and illustrated in the aforementioned figure, have positive and significant relationships.

3. METHOD

This research employs a quantitative method with a survey approach aimed at testing hypotheses using existing theories [31, 32]. The survey approach referred to is a systematic data collection method to obtain information from a group of people (respondents) about a specific topic or phenomenon. In this study, a questionnaire was utilized as the data collection instrument. The questionnaire measured each response using a seven-point Likert scale, ranging from strongly agree (score seven) to strongly disagree (score one). The assessment comprised five crucial constructs.

Firstly, the "intention to use pesticides" construct consisted of five indicators, such as efforts to maximize agricultural production, storage of pesticides in separate warehouses, planning pesticide use in the near future, the intention to spray pesticides based on expert advice, and the reduction of pesticide use on crops.

Secondly, the "attitude" construct also comprised five indicators, including awareness of the impact of excessive pesticide use on health, understanding that pesticide use can harm ecosystems and wildlife, the view of the necessity of pesticide use to enhance productivity, awareness of negative environmental impacts, and views on successful farmers producing healthy products without pesticides.

Thirdly, the "subjective norm" construct included four indicators, such as family prohibition on increased pesticide use, the belief that more pesticide use will yield more products, acceptance of criticism from agricultural experts regarding excessive pesticide use, and approval from close friends regarding pesticide use for pest control.

Fourthly, the "perceived behavioral control" construct consisted of five indicators, including knowledge that pesticides should be kept away from children, considerations of pesticide price related to increased productivity, awareness of the availability and accessibility of pesticides, a positive view of cultivation without spraying, and the absence of financial problems to purchase pesticides.

Lastly, the "knowledge of pesticides" construct comprised six indicators, such as understanding that spraying in windy conditions reduces pest control, selecting the right time for spraying can reduce pesticide use, frequent spraying can eliminate pests and increase productivity, understanding the prohibition of some pesticides, awareness that spraying can pollute water sources, and understanding that careless spraying can trigger pest resistance.

In determining the sample size, this research followed the "rule of thumb" formula [33] which stipulates that the sample size should be greater than 10 times the number of manifest variables (indicators). Given the 25 indicators, the required sample size was calculated to be 250 respondents.

In the data analysis stage, the research employed Structural Equation Modeling (SEM) using the SmartPLS software. SEM was utilized to test causal relationships by combining factor analysis and path analysis. This process involved two validity tests: one for the Measurement Model and another for the Structural Model. The validity tests included Standardized Regression Weights, AVE, and CR to assess the fit of indicators to their constructs. The subsequent steps involved hypothesis testing for Structural Model relationships, as expressed in Regression Weights [34].

4. RESULT AND DISCUSSION

4.1 Results of the outer model

The outer model serves as a measurement model utilized to assess the validity and reliability of a model. To evaluate the unidimensionality of a construct, the outer model can be employed by leveraging composite reliability and convergent validity. This process involves constructing latent variables within a path diagram. From the results of the outer model in this study, the validity of the instrument is determined as follows:

Table 1. Outer loadings

Laten Variable	Items	Loadings Value
Attitude	Att1	0.818
	Att2	0.790
	Att3	0.820
	Att4	0.853
	Att5	0.699
Intention to Use Pesticides	In1	0.800
	In2	0.829
	In3	0.855
	In4	0.694
	In5	0.785
Knowledge	Know1	0.866
	Know2	0.848
	Know3	0.821
	Know4	0.873
	Know5	0.878
	Know6	0.757
Perceived Behavioral Control	PBC1	0.857
	PBC2	0.859
	PBC3	0.847
	PBC4	0.872
	PBC5	0.786
Subjective Norm	SN1	0.829
	SN2	0.877
	SN3	0.834
	SN4	0.641

According to Aburumman et al. [35], the results of the validity test provide an indication of the extent to which a measuring instrument is capable of measuring the desired aspects. The validity assessment of an indicator can be observed from the loading values, and in the context of exploratory research, a range of values between 0.5 and 0.6 is considered adequate. Therefore, based on the results of the validity test in this study (refer to Table 1), all items are considered valid as they have loading values greater than 0.5.

Furthermore, discriminant validity evaluation is conducted using the Average Variance Extracted (AVE) method for each construct or latent variable. The model is said to have better discriminant validity if the square root of AVE for each construct is greater than the correlation between two constructs in the model [36]. The results in Table 2 indicate that the AVE values for all constructs exceed 0.50. Therefore, the tested model demonstrates adequate convergent validity.

According to Hair et al. [37], the purpose of reliability testing is to demonstrate the extent to which a measurement tool can be trusted or relied upon, measured using composite reliability. In this context, the cut-off value used is a minimum of 0.7. However, for exploratory research, reliability is considered adequate in the range of 0.5 to 0.6, as explained by Ferdinand [38]. Therefore, the evaluation of the validity and reliability of the outer model plays a key role in ensuring the accuracy and reliability of a measurement model. Based on the results of the reliability test in this study (see Table 2), it is known that all research instruments used are considered reliable because the composite reliability and Cronbach's alpha values are greater than 0.7.

Table 2. Construct reliability and validity

	Cronbach's Alpha	rho_A	Composite Reliability	Average Variance Extracted (AVE)
Attitude	0.856	0.863	0.897	0.636
Intention to Use Pesticides	0.853	0.860	0.895	0.631
Knowledge	0.917	0.918	0.936	0.708
Perceived Behavioral Control	0.899	0.901	0.926	0.713
Subjective Norm	0.807	0.811	0.876	0.641

4.2 Inner model results

The inner model functions as a structural model that predicts the causal relationships between latent variables. This predictive process is carried out through bootstrapping methods, with T-statistic test parameters employed to predict the presence of causality relationships. Structural model testing is conducted to examine the causal relationships among latent variables. The findings of the inner model in this study encompass insights into the elucidated causality relationships as follows:

Table 3. R Square

	R Square	R Square Adjusted
Attitude	0.577	0.575
Intention to Use Pesticides	0.739	0.736
Perceived Behavioral Control	0.422	0.420
Subjective Norm	0.427	0.424

Table 3 provides information about R Square (R^2) and Adjusted R Square for each variable in the analysis model. R Square, as the coefficient of determination, measures the proportion of variation in the dependent variable that can be explained by the independent variables in the model. For the Attitude variable, approximately 57.7% of its variation can be explained, with an almost equivalent Adjusted R Square, indicating consistency in results after adjustment. The Intention to use pesticides variable has an R Square of 73.9%, and the nearly equivalent Adjusted R Square suggests consistency after adjustment. Perceived Behavioral Control and Subjective Norm, each with R Squares around 42.2% and 42.7%, respectively, have nearly equal Adjusted R Squares, indicating consistency in results after adjustment. A higher R Square value implies a better ability of the model to explain variation in the dependent variable. The use of Adjusted R Square provides a conservative overview of how well the model explains variation, considering the number of independent variables.

In the Partial Least Squares (PLS) analysis, each relationship is tested using simulation with the Bootstrapping method on the sample. This approach is employed to address potential issues of data non-normality in the research. The results of the testing using the Bootstrapping method in this study will be outlined as Figure 2.

To assess the structural relationships among latent variables, it is necessary to conduct hypothesis testing on the path coefficients between variables by comparing the p-value to alpha (0.005) or the t-statistic, which should exceed 1.96. The magnitude of the p-value and t-statistic is obtained from SmartPLS output by applying the bootstrapping method. The results of hypothesis testing in this study can be seen in Table 4 and Figure 2 below:

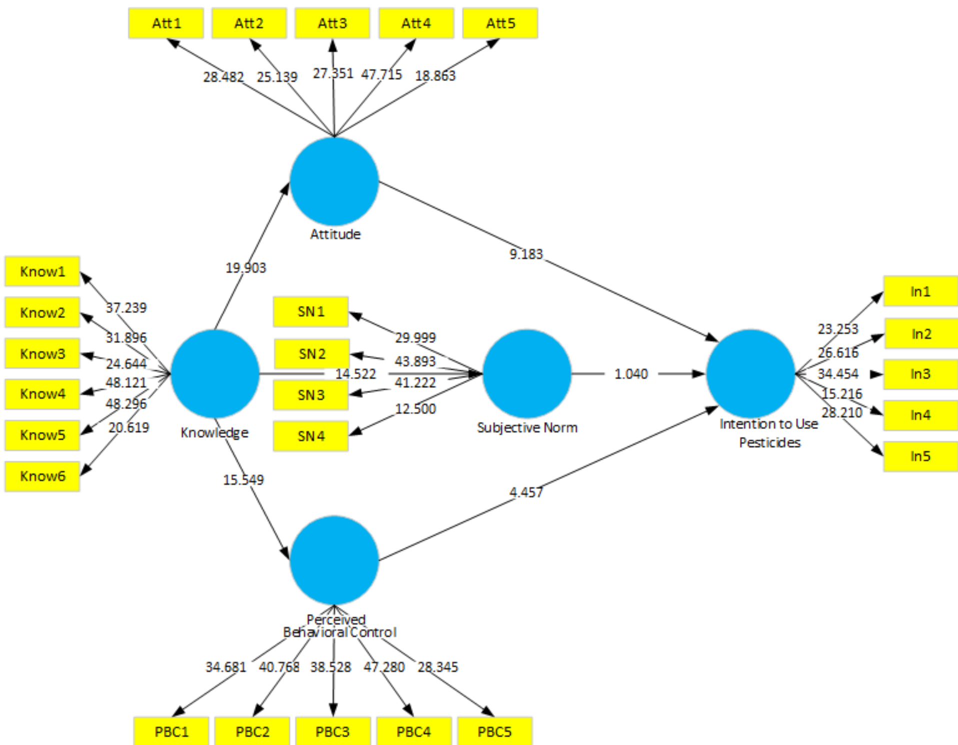

Figure 2. Bootstrapping

Table 4. Path coefficients

	Original Sample	Sample Mean	Standard Deviation	T Statistics	P Values
Attitude -> Intention to Use Pesticides	0.748	0.746	0.081	9.183	0.000
Knowledge -> Attitude	0.760	0.762	0.038	19.903	0.000
Knowledge -> Perceived Behavioral Control	0.650	0.654	0.042	15.549	0.000
Knowledge -> Subjective Norm	0.653	0.658	0.045	14.522	0.000
Perceived Behavioral Control -> Intention to Use Pesticides	0.262	0.267	0.059	4.457	0.000
Subjective Norm -> Intention to Use Pesticides	-0.081	-0.081	0.078	1.040	0.299

Table 4 presents the results of hypothesis testing revealing the relationship between the attitude and intention to use pesticides variables. This relationship is significantly positive, as indicated by a path coefficient value of 0.748 ($T = 9.183$, $p < 0.005$), suggesting that a positive attitude towards pesticide use correlates with the intention to use them. Individual attitudes reflect personal evaluations of pesticide use, influenced by knowledge, risk perceptions, and personal experiences.

Furthermore, the relationship between the Knowledge variable and the Attitude variable ($T = 19.903$, $p < 0.005$), Knowledge and perceived behavioral control ($T = 15.549$, $p < 0.005$), as well as Knowledge and Subjective Norm ($T = 14.522$, $p < 0.005$) is also significantly positive. These results indicate that higher knowledge is positively correlated with attitude, behavioral control, and subjective norm related to pesticide use.

Several reasons support these hypothesis test results, including the fact that in-depth knowledge about pesticides can shape a positive attitude towards their use. Knowledge about application and environmental impact can also influence perceptions of behavioral control and subjective norms. With sufficient knowledge, individuals can develop subjective norms that either support or oppose pesticide use, creating a balance between attitude, behavioral control, and subjective norms in pesticide-related decision-making.

Moreover, the results show that the relationship between perceived behavioral control and intention to use pesticides is significantly positive ($T = 4.457$, $p < 0.005$). This indicates that perceptions of behavioral control influence the intention to use pesticides. Perceived behavioral control includes factors such as technical knowledge and resource availability. If individuals feel capable of overcoming these constraints, the tendency to use pesticides is higher.

However, the relationship between Subjective Norm and intention to use pesticides is not significant ($T = 1.040$, $p = 0.299$). This suggests that subjective norms do not significantly influence the intention to use pesticides. This may be due to weak social pressure regarding pesticide use within existing social norms. Factors such as knowledge, attitude, and perceptions of behavioral control are more dominant in influencing individual intentions to use pesticides than the social pressure represented by Subjective Norm.

Subjective norms essentially reflect an individual's beliefs about what is considered right or wrong in a particular context. Regarding pesticide use, subjective norms may refer to an individual's beliefs about whether pesticide use is deemed appropriate or not. In the theory of planned behavior, subjective norms interact with attitude and behavioral control to form intention to use. However, in this research, there is an interesting finding regarding pesticide use in Indonesia, where subjective norms do not seem to have a significant impact on intention to use. This is influenced by several underlying factors.

Firstly, the lack of public awareness about the dangers of pesticides, where many still consider pesticide use as common and not harmful. Furthermore, the limited access to information about pesticide hazards, especially in rural areas, can be a barrier. This condition results in a lack of understanding of the risks of pesticide use and diminishes the impact of subjective norms on the intention to use pesticides. Cultural influence is also a significant factor, where in some Indonesian cultures, pesticide use is considered a normal and even necessary step to enhance agricultural productivity. On the contrary, knowledge and attitudes seem to play a stronger role in shaping intention to use in the context of pesticide use.

Adequate knowledge about pesticide dangers can increase individual awareness of risks and potential negative impacts. Thus, knowledge can influence individual attitudes toward pesticide use. Positive attitudes toward pesticide use can also be reinforced by the perception that pesticides are effective in controlling plant pests and diseases. Additionally, the belief that pesticide use does not harm human health and the environment can strengthen this positive attitude. Therefore, a better understanding of knowledge and attitudes can be key to developing effective strategies to reduce pesticide use or encourage more sustainable farming practices in Indonesia.

5. CONCLUSION AND RECOMMENDATIONS

This study reveals significant findings, emphasizing a strong positive relationship between knowledge, attitude, and perceived behavioral control with the intention to use pesticides. In-depth analysis indicates that knowledge plays a central role in shaping individuals' attitudes towards pesticides. As awareness of the application and environmental impact of pesticides increases, individuals tend to develop positive attitudes towards using them. In this context, attitudes, as a result of personal evaluation, are influenced by various factors including knowledge, risk perception, and personal experiences. In the context of pesticide use, a positive attitude can be considered an indicator that individuals believe in the benefits of pesticide use and view it as an effective solution. Therefore, improving knowledge about pesticides can directly impact the formation of attitudes that support pesticide use.

In addition to knowledge, perceived behavioral control also emerges as a significant factor in understanding individuals' intentions to use pesticides. Perceived behavioral control encompasses individuals' beliefs in their ability to control pesticide use actions. Research findings indicate that individuals with high levels of perceived behavioral control tend to have stronger intentions to use pesticides. This suggests that, in addition to having adequate knowledge, individuals need to feel sufficiently in control when implementing pesticide use actions.

The importance of subjective norms is also revealed in the context of pesticide use. Although findings indicate that subjective norms do not have a significant impact on the intention to use pesticides, they remain an essential element in understanding individual behavior. Subjective norms reflect social pressure and norms accepted by individuals from their environment. Nevertheless, social pressure from subjective norms seems less significant compared to other factors like knowledge and attitudes. In this regard, the balance between knowledge, attitudes, and perceived behavioral control in relation to pesticide use becomes increasingly clear. Individuals with adequate knowledge about pesticides, positive attitudes towards their use, and high perceived behavioral control tend to have stronger intentions to use pesticides. This balance reflects a complex interplay between psychological factors and behavioral control, both of which mutually influence decision-making concerning pesticide use.

In designing strategies or education programs to reduce unsustainable pesticide use, it is important to focus on increasing individuals' knowledge about pesticides, fostering positive attitudes towards environmentally friendly alternatives, and strengthening perceived behavioral control. Additionally, it should be noted that subjective norms, although not significant in this research, can still play a crucial role in specific social contexts. Therefore, a holistic and integrated approach is needed to achieve sustainable behavioral changes related to pesticide use.

The limitations of this study lie in its deeper focus on subjective norms. While subjective norms may not significantly influence pesticide use in this research, they still play a crucial role within specific social contexts in Indonesia. For instance, within traditional farming communities in rural areas, strong subjective norms might influence their decisions regarding pesticide use. Despite having knowledge about the risks and benefits, decisions regarding pesticide use can be influenced by cultural norms, traditions, and collective beliefs. For example, if there is a longstanding tradition in society to use a particular pesticide at certain times, these subjective norms can reinforce the decision to use pesticides even when safer alternatives are available. Therefore, although subjective norms may not be a major factor in the related research, their role in specific social contexts remains crucial in shaping pesticide use behavior in Indonesia. To address these limitations, suggestions for further research encompass several aspects. Firstly, further research can delve deeper to understand the social contexts that may reinforce or reduce the influence of subjective norms on intentions to use pesticides. Focusing on the dynamics of specific social or cultural groups can provide additional insights. Additionally, it is important to incorporate external factors into the analysis, such as government regulations, agricultural policies, or environmental campaigns. This can help sharpen the understanding of how these factors influence intentions and behaviors related to pesticide use.

Future research can also focus on designing and testing educational programs or information campaigns. The goal is to increase knowledge, change attitudes, and strengthen perceived behavioral control related to pesticide use. It is important to pay attention to approaches that can be adapted to various contexts in developing these interventions. Economic analysis of pesticide use and consideration of environmentally friendly agricultural alternatives can provide a more comprehensive view. Thus, efforts to reduce unsustainable pesticide use can be supported by a thorough understanding of economic aspects and available alternatives. In other words, future research is expected to expand knowledge about factors influencing intentions and behaviors related to pesticide use. Additionally, designing more effective interventions to support sustainable farming practices will be a crucial step in supporting environmental sustainability.

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