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INVESTIGATING THE IMPACT OF PESTICIDE LABELLING INFORMATION ON FARMERS' PESTICIDE USE DECISIONS IN MALAYSIAN AGRICULTURE

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***Abstract*—** This research investigates the impact of pesticide labelling information on farmers' pesticide use decisions in Malaysian agriculture. The study aims to examine the relationship between pesticide labelling information and farmers' decisions, explore the influence of farmers' knowledge, attitudes, and practices, and assess whether these factors mediate the relationship between labelling information and decisions. A positivist research philosophy, deductive research approach, and mono-method quantitative design are employed, utilizing surveys with a convenience sample of 100 respondents. The findings reveal a diverse demographic composition of the respondents, with a significant presence of Chinese farmers and a majority having tertiary education. Surprisingly, respondents exhibit a balance between new and experienced farmers. The analysis of research hypotheses indicates a significant relationship between pesticide labelling information and farmers' knowledge, attitudes, and practices, as well as between these factors and pesticide use decisions. However, the study fails to support the hypothesis that pesticide labelling information directly affects pesticide use decisions. Instead, it highlights the mediating role of farmers' knowledge, attitudes, and practices. This suggests that improving farmers' understanding of pesticide-related information and promoting responsible practices may be more influential in shaping their decisions. Overall, this research contributes to academic understanding and practical actions in Malaysian agriculture, offering insights for policy improvements and on-the-ground practices. Future research directions include longitudinal studies, comparative analyses, and behavioural economics principles to deepen our understanding of pesticide decision-making and enhance sustainable agricultural practices in Malaysia.

Keywords—Pesticide Labelling Information, Farmers' Knowledge, Attitudes, Practices, Farmers' Decisions

I. INTRODUCTION

Agriculture is an important sector of the Malaysian economy, providing employment to a significant percentage of the population and contributing to the country's food security. According to the Annual Economic Statistics (AES) Agriculture Sector, 2022 (2023), it shows that the agriculture sector comprising four sub-sectors namely crops, livestock, fisheries, forestry and logging. Malaysian agriculture experienced a 23.2 percent growth rate and resulting in an increase in the gross output value from RM82.2 billion in 2020 to RM101.3 billion in 2021 as reported by Annual Economic Statistics (AES) Agriculture Sector, 2022 (2023).

Pesticides are widely used in Malaysian agriculture to increase crop yield and control pests. Pesticide labelling is an essential tool in promoting the safe use of pesticides. The labels on pesticide containers provide information on the proper use, handling, storage, and disposal of pesticides. Despite the presence of pesticide labelling regulations, farmers may not fully understand the information provided on pesticide labels and follow the information provided. The misuse of pesticides can have adverse effects on human health and the environment.

The lack of awareness and understanding of pesticide labelling information can lead to the improper use of pesticides, resulting in negative impacts on the environment, human health, and wildlife. Farmers may use excessive amounts of pesticides or use them inappropriately, which can contaminate water sources, soil, and air, harm non-target organisms, and pose risks to human health. Pesticide residues in food crops can cause health problems to consumers. As reported by Dermawan (2023), the Consumers' Association of Penang (CAP) found that some vegetables and rice sold in the local markets contain high levels of pesticide residues. This can pose a significant health risk to consumers, particularly children who are more susceptible to the adverse effects of pesticides.

Furthermore, the issue of pesticide misuse is not limited to Malaysia but is a global concern. According to Boedeker et al. (2020), an estimated 385 million cases of unintentional acute pesticide poisoning happen every year globally, leading to approximately 11,000 deaths. This means that around 44% of farmers, based on a worldwide farming population of approximately 860 million, are affected by pesticide poisoning annually.

In addition, the issue of pesticide misuse can lead to the development of pesticide resistant pests. The overuse of pesticides can create a selection pressure on pests, leading to the evolution of pesticide-resistant pests. This reduces the effectiveness of pesticides in pest management, leading to more significant pest problems and the need for more potent and toxic pesticides. Idris (2023) mentioned that the use of pesticides increased the frequency of resistance in pests by a factor of 6.5. This implies that pests develop greater

resistance to the same pesticide with time, reducing its efficacy. This poses a significant challenge for farmers who will need to overuse pesticides to combat the same pests.

Despite the enforcement of the Pesticides Act 1974, farmers in Malaysian agriculture may have a poor understanding of pesticide labelling information. This lack of understanding could lead to poor pesticide use decisions and increase the risk of adverse effects on human health and the environment. In response to concerns over the potential impacts of pesticides, regulatory efforts have been made to improve the availability and accuracy of pesticide labelling information. To promote sustainable pesticide use in Malaysian agriculture, it is crucial to investigate the impact of pesticide labelling information on farmers' pesticide use decisions. Such investigations can identify factors that influence farmers' understanding and use of pesticide labelling information.

II. LITERATURE REVIEW

A. Pesticide Labelling Information

A study on the effectiveness of pesticide labels as a communication tool for smallholder farmers on pesticides handling was conducted by Kapeleka & Mwaseba (2017). They used a structured interview schedule to identified factors influencing the use of information on pesticide labels and employed simple descriptive statistics and cross-tabulation for analysis (Kapeleka & Mwaseba, 2017). The study uncovered that the majority (79.6%) of farmers interviewed did not learn anything from the labels and the majority (66.7%) of farmers obtain information about pesticides from retailers (Kapeleka & Mwaseba, 2017). More than half (60%) of the farmers are unable to interpret warning symbols and pictograms correctly (Kapeleka & Mwaseba, 2017). Despite 76.1% of farmers reading pesticide labels before use, most do not comprehend the instructions provided on the label due to foreign and technical language, unclear information, and the use of uncommon Swahili words (Kapeleka & Mwaseba, 2017). The study recommends that pesticide labels should be simplified, and provide training on symbols, colour codes, pictograms, safety precautions, and the health and environmental impacts of pesticide use is crucial for farmers (Kapeleka & Mwaseba, 2017).

B. Farmers' Pesticide Use Decisions

A study on the purchasing and utilizing of pesticide among smallholder vegetable farmers in Ethiopia was conducted by Mengistie et al. (2015). A total of 220 smallholder farmers interviewed, 79% of them mentioned that the efficacy of the pesticide is the most important factor when selecting pesticides whereas 21% of them cared more about the price and if they could afford it (Mengistie et al., 2015). Pesticides cost the most for farmers when they grow tomatoes and onions, more than other things like fertilizers, workers,

water pumps, or seeds (Mengistie et al., 2015). Farmers didn't really think about how dangerous pesticides might be for them or for the people who eat what they grow, or about their effects on the environment (Mengistie et al., 2015). They often bought cheaper pesticides that can kill many kinds of pests (like DDT), even though these can be harmful (Mengistie et al., 2015). Farmers usually bought small amounts of pesticides and didn't read the instructions much. For example, 67% didn't check if the pesticides were expired, and most farmers (55%) couldn't read (Mengistie et al., 2015). According to Mengistie et al. (2015), information provided by supplier can significantly impact the accurate and effective choice of pesticides, particularly for small scale farmers who lack other reliable sources of guidance. However, none of the pesticide importers had experts at the local or farm level to share information, evaluate how retailers manage products, or handle farmers' concerns. Farmers primarily rely on neighbours and their own past experiences when picking and using pesticides. Since the majority of farmers (60%) choose and use pesticides based on their own familiarity, those with over five years of farming experience are likely to be knowledgeable about available pesticide names and qualities in the market (Mengistie et al., 2015).

C. Farmers' Knowledge, Attitude and Practice (KAP)

A study on the levels of knowledge, attitude and practices of Kuwaiti farmers regarding the safe use of pesticides was conducted by Jallow et al. (2017). Among 250 farmers interviewed, most farmers knew that pesticides were bad for their health (71%) and the environment (65%) (Jallow et al., 2017). Over 70% didn't read or follow the instructions on pesticide labels, and 58% didn't wear protective gear when using pesticides (Jallow et al., 2017). Educated farmers were better at using protective gear than those with less education. Around 20% of farmers stored pesticides in their living areas, which is unsafe (Jallow et al., 2017). When disposing of pesticide containers, many farmers adopted harmful practices like burying or burning them or even reuse the container. Although farmers know that pesticides are risky, they do not always act safely, with 82% of farmers reporting symptoms of acute pesticide poisoning (Jallow et al., 2017). To make things better, we need to teach farmers about safe pesticide use, enforce pesticide laws, and promote ways of controlling pests that don't involve harmful chemicals.

III. RESEARCH METHODOLOGY

This research will use questionnaire survey that is a type of quantitative research method involves asking respondents a series of pre-determined questions to collect data from farmers in Malaysia. This approach is useful when studying the impact of pesticide labelling information on farmers' pesticide use decisions, as it allows for the collection of large amounts of data from a series of pre-determined questions, allowing for fast and efficient collection of data from farmers in Malaysia.

A. *Conceptual Framework*

The conceptual framework for this study is based on the independent variable, dependent variable and mediator variable as shown in Fig. 1.

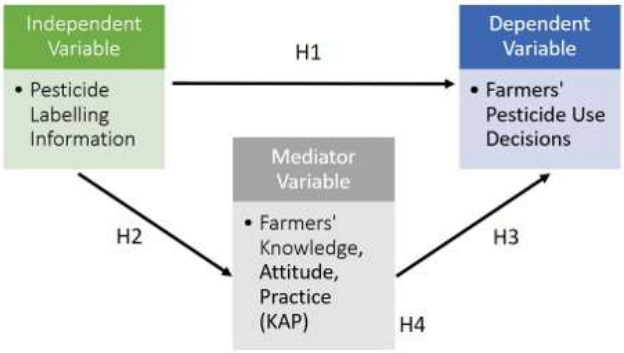

Fig. 1. Conceptual Framework

Based on this conceptual framework, the purpose of the study is to investigate the relationship between pesticide labelling information and farmers' pesticide use decisions in the context of Malaysian agriculture. Pesticide labelling information is the independent variable that is being manipulated in the study. It refers to the information provided on pesticide labels, including the active ingredients, usage instructions, safety warnings, and other details that might influence a farmer's decision to use a particular pesticide. Farmers' pesticide use decisions are the outcome variable in this research. This variable is being measured to determine the impact of the independent variable. This variable refers to the choices that farmers make when deciding whether to use pesticides, as well as the types of pesticides they choose to use. The dependent variable could be measured in terms of the types and the frequency of pesticides used by farmers.

A mediating variable is a variable that may explain the relationship between the independent variable and dependent variable. In the context of the study, the mediating variable could be knowledge, attitude and practice (KAP).

B. *Data Analysis Method*

The primary data gathered from the questionnaires survey is undergone data analysis via the SMART PLS 4 software. To assess the model's outcomes, the method employed for sampling will involve the utilization of Partial Least Squares Structural Equations Modeling (PLS-SEM). It is particularly well-suited for complex research studies that involve multiple variables, as well as studies with smaller sample sizes. It is assessing the strength and significance of the relationships between variables and constructs. The

factors like internal consistency (reliability) and convergent and discriminant validity are analysed to ensures that the chosen indicators accurately represent their underlying constructs.

After confirming the measurement model's validity, the structural model analysis is undergone to examine the relationships between constructs, particularly focusing on the impact of pesticide labelling information on farmers' pesticide use decisions. It calculates path coefficients, R-squared values, and other relevant statistics. To assess the statistical significance of the relationships, SMART PLS 4 uses bootstrapping. This technique generates multiple resamples from the dataset to estimate the distribution of results. It provides confidence intervals and p-values to determine whether the relationships are statistically significant. The overall fit of structural model is evaluated using goodness-of-fit measures like the Q-squared value. This indicates how well the model predicts the dependent constructs based on the independent ones.

IV. RESULTS

A. *Structural Model*

The PLS-SEM model for this study is shown in Fig. 2 based on the research framework.

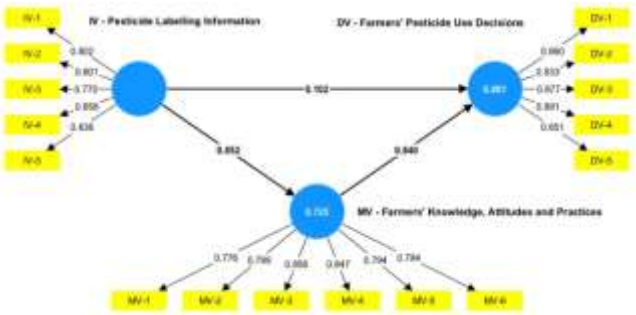

Fig. 2. PLS-SEM Model of the Study

B. *Structural Model Path Coefficients*

After PLS-SEM analysis was performed, the validity and reliability are evaluated. Then, bootstrapping is employed to determine the statistical significance of various outcomes from the PLS-SEM, such as path coefficients. These coefficients encompass key statistical measures like the mean, standard deviation, t-value, and p-value. These coefficients provide a detailed understanding of the relationships between different variables in the model and the impact they have on each other.

TABLE I. STRUCTURAL MODEL PATH COEFFICIENT (BOOTSTRAPPING OF 5000 SAMPLES)

	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values
IV -> DV	0.102	0.102	0.075	1.364	0.173
IV -> MV	0.852	0.852	0.027	31.556	0
MV -> DV	0.84	0.841	0.069	12.162	0

Table I presents the results from a structural model analysis using bootstrapping. Original sample (O) refers to the path coefficients calculated from the original dataset without any resampling. Sample mean (M) represents the average value of the path coefficients obtained from bootstrapping. Standard deviation (STDEV) indicates the variability or dispersion of the path coefficients across the bootstrapped samples. A higher standard deviation suggests greater variability in the estimated path coefficients. T statistics (|O/STDEV|) indicates how many standard deviations the original path coefficient is away from the mean of the bootstrapped coefficients. Larger values of T statistics suggest stronger deviations from the bootstrapped mean. P values represent the probability of observing the calculated T statistics (or more extreme values) assuming that there is no significant effect or relationship. A low p-value (usually less than 0.05) suggests that the relationship is statistically significant.

In Table I, the p-value of IV-DV is 0.173 and it is greater than 0.05 which means there is no significant relationship between Pesticide Labelling Information (IV) and Farmers' Pesticide Use Decisions (DV). In contrast, the p-value of IV-MV and MV-DV are less than 0.05, indicated the presence of a significant relationship between Pesticide Labelling Information (IV) and Farmers' Knowledge, Attitudes and Practices (MV), as well as Farmers' Knowledge, Attitudes and Practices (MV) and Farmers' Pesticide Use Decisions (DV).

C. *Coefficient of Determination (R^2)*

Table II presents the results of the coefficient of determination (R^2) analysis in this research study.

TABLE II. RESULTS OF COEFFICIENT OF DETERMINATION (R^2)

	R-square	R-square adjusted
DV - Farmers' Pesticide Use Decisions	0.861	0.851
MV - Farmers' Knowledge, Attitudes and Practices	0.725	0.715

In Table II, both constructs Farmers' Pesticide Use Decisions (DV) and Farmers' Knowledge, Attitudes and Practices (MV) have relatively high R^2 values that is 0.861 and 0.725, respectively. These indicated that the model's independent variables are effective in predicting and explaining the variability in these constructs. The adjusted R^2 values indicate that the model fit remains strong even when considering the complexity of the model.

D. *Effect Size (f^2)*

Table III presents the results of the effect size (f^2) analysis in this research study. Effect size measures are used to understand the practical significance or magnitude of the relationships between variables.

TABLE III. RESULTS OF EFFECT SIZE

	DV	IV	MV
DV			
IV	0.021		2.638
MV	1.399		

In Table III, the value of 0.021 indicates a very small effect size. It shown that the Pesticide Labelling Information (IV) has a relatively minor practical impact on the variation in Farmers' Pesticide Use Decisions (DV). A larger effect size with the value of 1.399 and 2.638 indicates a stronger practical impact of Farmers' Pesticide Use Decisions (DV) on Farmers' Knowledge, Attitudes and Practices (MV) and Farmers' Knowledge, Attitudes and Practices (MV) on Pesticide Labelling Information (IV), respectively. Larger effect sizes indicate more substantial and practically significance relationships.

E. *Hypotheses Testing*

a) H1: There is no significant relationship between pesticide labelling information and farmers' pesticide use decisions in Malaysian agriculture: From Fig. 3 , the result of this study does not support H1, as the p value of 0.173 is greater than 0.05, indicates that there is no significant relationship between pesticide labelling information and farmers' pesticide use decisions in Malaysian agriculture.

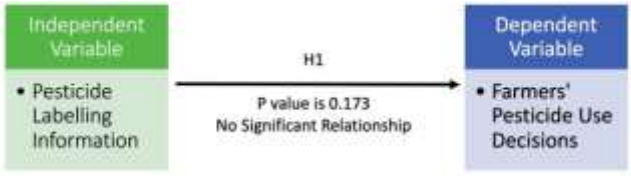

Fig. 3. H1: There is no significant relationship between pesticide labelling information and farmers' pesticide use decisions in Malaysian agriculture

b) H2: There is a significant relationship between pesticide labelling information and farmers' knowledge, attitudes and practices in Malaysian agriculture: From Fig. 4, the result of this study has support H2, as the p value of 0 is less than 0.05, indicates that there is a significant relationship between pesticide labelling information and farmers' knowledge, attitudes and practices in Malaysian agriculture.

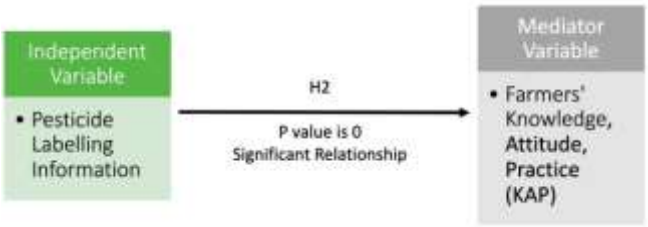

Fig. 4. H2: There is a significant relationship between pesticide labelling information and farmers' knowledge, attitudes and practices in Malaysian agriculture

c) H3: There is a significant relationship between farmers' knowledge, attitudes and practices and farmers' pesticide use decisions in Malaysian agriculture: From Fig. 5, the result of this study has support H3, as the p value of 0 is less than 0.05, indicates that there is a significant relationship between farmers' knowledge, attitudes and practices and farmers' pesticide use decisions in Malaysian agriculture.

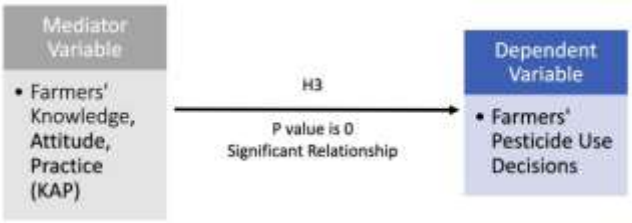

Fig. 5. H3: There is a significant relationship between farmers' knowledge, attitudes and practices and farmers' pesticide use decisions in Malaysian agriculture

d) H4: There is a significant difference in farmers' knowledge, attitudes and practices as a mediating influence between pesticide labelling information and farmers' pesticide use decisions in Malaysian agriculture: From Fig. 6 and Table IV, the result of this study has support H4, as the p value of 0 is less than 0.05, indicates that there is a significant difference in farmers' knowledge, attitudes and practices as a mediating influence between pesticide labelling information and farmers' pesticide use decisions in Malaysian agriculture.

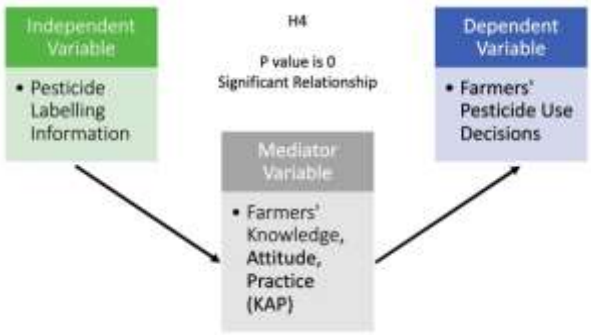

Fig. 6. H4: There is a significant difference in farmers' knowledge, attitudes and practices as a mediating influence between pesticide labelling information and farmers' pesticide use decisions in Malaysian agriculture

TABLE IV. RESULTS OF EFFECT SIZE

	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values
IV -> MV -> DV	0.715	0.716	0.055	13.122	0

V. CONCLUSION

The study found that the information provided on pesticide labels does not strongly determine farmers' decisions to use pesticides in Malaysian agriculture. This means other factors play a more important role in their decision-making process. Several studies are consistent with this concept, emphasizing the importance of understanding label content before applying pesticides. However, there are differing views, and some studies suggest that statements about health and environmental risks on labels can influence farmers' choices.

Additionally, the study revealed a link between information on pesticide labels and farmers' knowledge of pesticides, their attitudes toward use, and the practices they adopt. This suggests that label information can shape farmers' overall awareness and perceptions of pesticide use. This concept is reinforced by previous research showing that farmers often gain their knowledge about pesticide toxicity and proper methods of application from information displayed on pesticide labels.

Furthermore, the survey showed that the interconnectedness of farmers' knowledge, attitudes, and practices regarding pesticide use significantly influences their decisions about pesticide use. This means that when farmers have good knowledge and positive attitudes toward pesticide use, their decisions tend to align with their actual practices. The complexity of this relationship is underscored by varying results from various studies. Research shows that most farmers have a moderate level of pesticide knowledge. Their attitudes toward pesticide use indicate limited concern for environmental impacts, but some demonstrate responsible practices.

In addition, the study also found that farmers' knowledge, attitude, and practice levels were an intermediary factor affecting the link between pesticide label information and farmers' decisions to use pesticides in Malaysian agriculture. This suggests that the impact of pesticide labelling information on decision-making may be achieved through its impact on farmers' overall knowledge, attitude, and practice

related to pesticide use. This pattern is consistent with some previous research findings. The effectiveness of label information in promoting safe pesticide use depends on how important this information is to farmers and how effectively they incorporate it into their behaviour, attitudes and safer practices.

In summary, although pesticide label information may not be the primary driver of farmers' pesticide use decisions, this study highlights the critical role that farmers' knowledge, attitudes, and practices play in mediating the relationship between pesticide label information and decisions. This suggests that initiatives aimed at improving farmers' understanding of pesticide-related information and fostering positive attitudes and responsible practices toward pesticide use can have a more substantial impact on their decision-making processes.

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