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Abstract

Safe handling of pesticides is critical in maintaining human well-being, protecting the environment, and achieving sustainable agricultural production. Research on farmers' awareness, practices, and adoption of safe pesticide use is vital to guide policy, training, and support programs. This study assessed these aspects among rice farmers in the Third District of Bulacan, covering the municipalities of San Rafael, San Ildefonso, San Miguel, and Doña Remedios Trinidad. Specifically, it aimed to examine the socio-demographic profile of farmers and evaluate how their knowledge, practices, and challenges influence responsible pesticide use. A total of 376 respondents were selected through proportional stratified random sampling based on the Registry System for the Basic Sectors in Agriculture. The results revealed that most farmers were male, aged 55 to 64, had elementary-level education, and worked primarily as tenant farmers. Despite their farming background, the majority displayed limited knowledge of pesticide safety, particularly in PPE use, storage and disposal, and compliance with labeling and regulations. In terms of behavior, farmers sometimes followed recommended safety measures in pesticide handling and application. Challenges such as limited access to training, unclear regulatory guidelines, and inadequate resources hindered consistent compliance. Statistical analysis showed no significant relationship between socio-demographic variables—such as age, sex, educational attainment, and civil status—and levels of awareness, problems encountered, or adoption of safe pesticide practices. These findings underscore the need for targeted farmer training, enhanced extension services, and stronger policy implementation to promote safer and more sustainable pesticide use.

Keywords: *agricultural practices, Bulacan, farm work, pesticide safety, rice farming*

Introduction

Agriculture has long served as a cornerstone of the Philippine economy, providing employment for millions and contributing significantly to the country's Gross Domestic Product (GDP) (Ichwandiani et al. 2025). To meet the increasing global demand for food, modern farming practices have intensified, resulting in greater reliance on chemical inputs—particularly pesticides—to protect crops and boost productivity (Food and Agriculture Organization [FAO], 2022). Pesticides are chemical or biological substances used

to control pests and are classified into insecticides, herbicides, fungicides, and rodenticides. In rice production, the most commonly used chemicals include cypermethrin, glyphosate, and mancozeb (Chouaibou et al., 2016).

While pesticides have played a vital role in increasing agricultural output, their improper use has raised serious concerns regarding health risks and environmental degradation (Gupta, 2023). In the Philippine context, pesticide safety has emerged as a significant concern, particularly in highly agricultural provinces such as Bulacan. Situated in Central Luzon, Bulacan is among the country's leading rice-producing areas. Its Third District—which includes the municipalities of San Rafael, San Ildefonso, San Miguel, and Doña Remedios Trinidad—is characterized by intensive rice cultivation, where the use of pesticides remains a common farming practice (Department of Agriculture [DA], 2021). In 2022, Bulacan's palay production reached approximately 394,000 metric tons, valued at about ₱6.8 billion, underscoring its critical role in both local and national food security (Philippine Statistics Authority [PSA], 2023).

Pesticide use is a common practice in Philippine agriculture, particularly in rice and vegetable farming, where insecticides, herbicides, and fungicides are widely applied. Studies have documented residues of pesticides such as cypermethrin, chlorpyrifos, and mancozeb in agricultural soils and nearby water bodies, raising concerns about persistence and ecological impacts (Del Prado-Lu, 2010; Del Prado-Lu, 2015). Farmers' health risks are also evident, as exposure to pesticides has been associated with acute symptoms including headaches, dizziness, skin irritation, and respiratory problems, often linked to limited training and inadequate use of personal protective equipment (Lu et al., 2010). These findings underscore the dual challenge of protecting both human health and environmental sustainability in Philippine farming systems.

Contributing factors to these unsafe practices include socio-economic vulnerabilities such as older age, low educational attainment, and tenancy, which limit farmers' ability to adopt proper safety measures. Cultural habits, lack of technical support, and economic constraints further exacerbate the problem. Many farmers operate in contexts where access to training is insufficient, protective gear is unaffordable, and enforcement of safety regulations is weak. These conditions perpetuate risky pesticide handling behaviors, leaving farmers and their communities more susceptible to health hazards and environmental harm.

Innovations in pesticide technology—such as microbial and botanical formulations and precision tools like drones and sensor-based applicators—have emerged to reduce human exposure and environmental contamination while maintaining crop protection efficacy (Maienfisch & Koerber, 2024). Despite national and regional efforts to promote pesticide safety, localized research at the municipal level remains scarce. There is a lack of empirical data connecting farmers' socio-demographic profiles—such as age, gender, education, and farming experience—to their awareness, current practices, and adoption of safe pesticide use (Ahmed, 2024). This knowledge gap is particularly evident in municipalities like San Miguel and Doña Remedios Trinidad, where geographic isolation further limits access to support services and new technologies.

Improper pesticide handling has been associated with a range of adverse health effects, including skin irritation, respiratory illness, neurological disorders, and increased cancer risk (Damalas & Koutroubas, 2016; Gupta, 2023). Environmental consequences, such as soil degradation, water contamination, and harm to non-target species, have also been widely documented (Tudi et al., 2021). These risks highlight the urgent need to strengthen farmers' training and compliance with safety standards.

This study aimed to assess the awareness, practices, and level of adoption of safe pesticide use among rice farmers in the Third District of Bulacan. Specifically, it sought to: (1) determine the socio-

demographic profile of rice farmers; (2) assess their level of awareness and current practices related to safe pesticide use; (3) identify problems encountered in pesticide application and handling; (4) evaluate their level of adoption of pesticide safety guidelines; and (5) analyze the relationship between socio-demographic characteristics and their awareness, practices, and adoption of safe pesticide use.

Materials and Methods

Research Design

The study employed a quantitative correlational research design to determine the relationships between the farmers' socio-demographic characteristics, pesticide awareness, current pesticide use practices, problems encountered, and their level of adoption of safe pesticide practices. This design enabled the analysis of associations among variables and the identification of patterns influencing responsible pesticide use among rice farmers in the Third District of Bulacan.

Population and Sampling Procedure

The study targeted 16,794 registered rice farmers recorded in the Registry System for the Basic Sectors in Agriculture (RSBSA). Applying Cochran's formula, a representative sample of 376 farmers was derived, based on a 95% confidence level and a 5% margin of error. Stratified random sampling was employed to guarantee proportional allocation across the four municipalities. Table 1 presents the sample distribution.

Table 1

Distribution of Respondents

Municipality	Total Population	Sample Size	Percentage (%)
Doña Remedios Trinidad (DRT)	1,188	27	7
San Rafael	3,006	67	18
San Ildefonso	4,564	102	27
San Miguel	8,036	180	48
Total	**16,794**	**376**	**100**

Research Instrument

A structured questionnaire was used to gather data from respondents. The instrument was adapted and modified based on previous studies related to pesticide safety (e.g., Sharifzadeh & Yarahmadi, 2019 and Zhao et al., 2022; and aligned with guidelines from the Fertilizer and Pesticide Authority (FPA, 2020). It consisted of six parts:(I) Socio-demographic profile, (II) Training and sources of information, (III) Awareness of pesticide safety, and the (IV) Current pesticide use practices, (V) Problems encountered in pesticide use, (VI) Level of adoption of safe pesticide practices

A five-point Likert scale was employed to assess agreement, frequency, and intensity across indicators. The instrument underwent content validation by experts in agricultural extension and pesticide safety. A pilot test was conducted with 30 farmers from outside the study area, and internal consistency reliability was established using Cronbach's Alpha, which yielded a coefficient of 0.89, indicating high reliability (Taber, 2018).

Data Collection Technique

Data were gathered through face-to-face interviews using the validated questionnaire. Trained enumerators conducted the interviews and were briefed on ethical standards, including confidentiality and respondent consent. Prior to participation, farmers were given an orientation and signed an informed consent form. Data collection spanned four weeks, covering the municipalities of Doña Remedios Trinidad, San Rafael, San Ildefonso, and San Miguel.

Data Analysis

Descriptive statistics, including frequencies, percentages, means, and standard deviations, were employed to present the demographic profile, levels of pesticide awareness, practices, encountered problems, and level of adoption. Associations between socio-demographic profiles and the main indicators were analyzed using the Pearson Chi-Square Test at a 0.05 level of significance. Data processing was completed using licensed SPSS software.

This study has a few limitations that should be recognized. First, the research was carried out only in the Third District of Bulacan, so the results may not fully apply to other areas. Second, since the data were based on self-reports, there is a chance that some responses were affected by memory lapses or the tendency to give socially acceptable answers. Third, the study looked at only a limited number of factors and did not include others, such as access to training, market incentives, or policy support, which could also influence pesticide practices. Lastly, because the study used a cross-sectional design, it captures only one moment in time and cannot show changes or trends that may happen in the long run.

Results and Discussion

Socio-Demographic Profiles of Farmers' Respondents

Before presenting the data in Table 2, it is important to highlight that the majority of farmers in the Third District of Bulacan belong to the aging population and have low levels of formal education. These characteristics can influence awareness, adoption, and safe pesticide use practices. Most respondents have been farming for more than a decade, suggesting long-term exposure to pesticide use.

Most farmers reported exclusive use of synthetic pesticides such as cypermethrin, glyphosate, and mancozeb. In North Cotabato, for example, cypermethrin was the most frequently applied insecticide, while glyphosate isopropylamine was the predominant herbicide (Lu & Salas, 2021). Although biopesticides were not reported as being in significant use, their adoption remains an untapped opportunity for promoting sustainable pest management in rice production (Horgan et al., 2023). Furthermore, the number of years farmers have been using pesticides generally corresponded with their overall farming experience, which in most cases ranged from 11 to 20 years, indicating long-term reliance on chemical pest control (Lu & Salas, 2021).

Table 2 shows that the majority of the 376 farmer-respondents were aged 55–64 years old (36.2%), followed by individuals aged 45–54 (28.5%) and those aged 65 years or older (25.5%), indicating that most of the farmers in the Third District of Bulacan belong to the aging population. A large percentage were males (73.7%) and married (89.9%). Most respondents had attained only elementary education (66.2%) and lived in households with 4–6 members (72.6%). Regarding sources of income, 84.3% relied solely on farming, while a few also engaged in livestock (14.4%) and business (1.3%). For tenurial status, 87.2% of respondents were tenants, with only 10.9% identified as landowners. Notably, the majority had 11–20 years of farming experience (67.6%), suggesting substantial exposure to farming practices over time.

Table 2

Socio-Demographic Profile Distribution of Farmers' Respondents

Category		Frequency (n=376)	Percentage (%)
Age			
	25-34	2	0.5
	35-44	35	9.3
	45-54	107	28.5
	55-64	136	36.2
	65 or over	96	25.5
Sex			
	Male	277	73.7
	Female	99	26.3
Civil status			
	Single	10	2.7
	Married	338	89.9
	Widowed	24	6.4
	Separated	4	1.1
Educational sttainment			
	Elementary	249	66.2
	High School	77	20.5
	Vocational	14	3.7
	College	35	9.3
	Masterals/Doctorate	1	0.3
Household size			
	1-3 members	35	9.3
	4-6 members	273	72.6
	More than 6 Members	68	18.1
Sources of income			
	Farming	317	84.3
	Livestock	54	14.4
	Business	5	1.3
Tenurial status			
	Landowner	41	10.9
	Tenant	328	87.2
	Leaseholder	7	1.9
Years of farming experience			
	Less than 5 Years	3	0.8
	5-10 Years	32	8.5
	11-20 Years	254	67.6
	More than 20 years	87	23.1

The findings indicate that most farmer-respondents are experienced and have been engaged in agriculture for many years. However, their generally low level of formal education and reliance on farming as a primary source of income highlight the need for targeted educational and support programs. Providing accessible training and introducing modern agricultural technologies could enhance their practices and boost productivity. The high prevalence of tenant farmers points to land security issues, which may discourage long-term investments in farm improvements. Larger household sizes, while offering additional labor, also come with increased financial burdens that affect agricultural decision-making and household well-being.

These findings have broader implications beyond the study area. Similar patterns have been

observed in other parts of the Philippines and other ASEAN countries, where limited access to formal education, insecure land tenure, and economic constraints hinder the prioritization of long-term sustainability, including pesticide safety. As Yuan and Sun (2024) note, older farmers with limited educational backgrounds are less likely to adopt new technologies, while McLain (2023) emphasize that tenure insecurity suppresses motivation for sustainable practices.

Awareness on Safe Pesticide Use

Understanding farmers' awareness of safe pesticide use is essential for evaluating potential health and environmental risks in agricultural communities. Awareness not only influences how pesticides are applied, but also affects the extent to which farmers adopt protective measures, comply with regulations, and prevent hazardous outcomes. Assessing awareness levels provides a foundation for identifying knowledge gaps and developing targeted training interventions.

Table 3

Level of Awareness of Farmers' Respondents on Pesticide Use

Statement	Mean	Standard Deviation	Verbal Interpretation
1. Application of proper dosage of pesticides.	2.99	0.837	Slightly Aware
2. Health risks of improper pesticide use.	3.21	0.873	Slightly Aware
3. Importance of wearing protective equipment.	2.95	0.902	Slightly Aware
4. Environmental impact of pesticide misuse.	3.11	0.918	Slightly Aware
5. Proper storage and disposal of pesticides.	2.94	0.863	Slightly Aware
6. Correct handling and mixing of pesticides.	3.04	0.906	Slightly Aware
7. Observance of the recommended waiting period before harvesting after pesticide application.	3.02	0.981	Slightly Aware
8. Reading the pesticide label instructions before use.	3.00	0.911	Slightly Aware
9. First aid measure in case of pesticide poisoning.	3.00	0.962	Slightly Aware
10. Government regulations and policies on pesticide use.	3.03	0.906	Slightly Aware
Overall Mean	**3.029**	**0.309**	**Slightly Aware**

Legend: 1.00–1.80 = Not Aware, 1.81–2.60 = Minimally Aware, 2.61–3.40 = Slightly Aware, 3.41–4.20 = Moderately Aware, 4.21–5.00 = Highly Aware

Table 3 presents the level of awareness of farmers regarding safe pesticide use. The overall mean awareness level is 3.03, (interpreted as "Slightly Aware"). Respondents showed minimal awareness (means scores ranging from 2.94–2.99) in critical areas such as the proper dosage of pesticides, the use of protective equipment, and proper storage and disposal. Slightly higher awareness (means scores of 3.00–3.21) was observed in areas like health risks, environmental impact, and reading pesticide labels and following first aid procedures.

These results suggest that although farmers have a basic understanding of the risks tied to pesticide use, their knowledge remains limited in areas crucial to safety. While there is slightly better awareness regarding health risks and regulations, significant gaps still exist in understanding proper pesticide handling and safety practices. This underscores the need for accessible educational campaigns and hands-on training to reduce health and environmental hazards.

Several studies support these findings. Knowledge of health risks, safety practices, acute pesticide poisoning, and associated factors among farmers in rural irrigation areas of northeastern Ethiopia Keleb et al. (2024) found minimal awareness despite existing programs, mainly due to a lack of education and training. Desye et al. (2024) and Lu et al. (2010) emphasized that increasing awareness through consistent training significantly reduces risk.

Current Farmers' Practices in Pesticide Application, Handling, and Disposal

The assessment of farmers' practices in pesticide use is crucial for understanding how pesticides are applied, handled, and disposed of at the farm level. Proper practices reduce risks to human health, minimize environmental contamination, and improve overall farm productivity. In this study, the practices of farmer-respondents were evaluated based on three major aspects—application, handling, and disposal of pesticides.

Table 4 presents the summary of their responses, showing the mean scores, standard deviations, and verbal interpretations according to the scale used.

Table 4

Summary of Current Practices of Farmers' Respondents on Pesticide Use

Practices	Mean	Standard Deviation	Verbal Interpretation
1. Application	3.070	0.372	Sometimes Practiced
2. Handling	3.030	0.405	Sometimes Practiced
3. Disposal	3.040	0.434	Sometimes Practiced
Overall Mean	**3.046**	**0.404**	**Sometimes Practiced**

Legend: 1.00–1.99 = Never Practiced, 2.00–2.99 = Rarely Practiced, 3.00–3.99 = Sometimes Practiced, 4.00–4.99 = Often Practiced, 5.00 and above = Always Practiced

Table 4 summarizes the farmers' practices related to pesticide use. The overall mean score was 3.05, interpreted as "Sometimes Practiced." Specifically, pesticide application practices had a mean of 3.07, indicating occasional compliance with safety protocols like reading labels and avoiding water contamination. However, critical safety behaviors—such as avoiding application during windy or rainy conditions—were not regularly followed.

Handling practices had a mean of 3.03, with inconsistent use of PPE, hygiene practices, and safe storage. Disposal practices showed a mean of 3.04, reflecting occasional use of triple-rinsing and avoidance of burning, but with many still lacking adherence to proper disposal regulations.

These results reflect an awareness-practice gap. Despite recognizing the importance of safe pesticide use, actual implementation is limited by infrastructure, enforcement, and training availability. Kumar et al. (2019) and Nayak and Solanki (2021) report similar patterns of limited practice despite awareness due to weak enforcement and economic limitations.

Problems Encountered in Pesticide Use

The use of pesticides is often associated with various challenges that farmers encounter during application, handling, and disposal. These challenges may include difficulties in applying the proper dosage, exposure to health risks, and limited adherence to safety practices such as wearing protective equipment or following recommended waiting periods before harvest.

Farmers also face constraints in understanding and complying with government regulations and policies on pesticide use, which further influence their management practices. To capture these concerns, the study examined the extent to which farmers' encountered problems related to pesticide use, as summarized in Table 5.

Dhillon and Moncur (2023) and Van et al. (2024) reported that these challenges—particularly lack of access to safety equipment and weak enforcement—are common across many farming communities. Maddah et al. (2020) recommended community-based interventions to address these persistent issues.

Table 5

Problems Encountered in Pesticide Use of Farmers' Respondents

Statement	Mean	Standard Deviation	Verbal Interpretation
1. Application of proper dosage of pesticides.	3.120	0.921	Sometimes Encountered
2. Health risks of improper pesticide use.	3.150	0.882	Sometimes Encountered
3. Importance of wearing protective equipment.	3.200	0.911	Sometimes Encountered
4. Environmental impact of pesticide misuse.	3.200	0.938	Sometimes Encountered
5. Proper storage and disposal of pesticides.	3.150	0.934	Sometimes Encountered
6. Correct handling and mixing of pesticides.	3.140	0.871	Sometimes Encountered
7. Observance of the recommended waiting period before harvesting after pesticide application.	3.200	0.866	Sometimes Encountered
8. Reading the pesticide label instructions before use.	3.170	0.887	Sometimes Encountered
9. First aid measure in case of pesticide poisoning.	3.180	0.907	Sometimes Encountered
10. Government regulations and policies on pesticide use.	3.250	0.903	Sometimes Encountered
Overall Mean	**3.174**	**0.433**	**Sometimes Encountered**

Legend: 1.00–1.80 = Never Encountered, 1.81–2.60 = Rarely Encountered, 2.61–3.40 = Sometimes Encountered, 3.41–4.20 = Often Encountered, 4.21–5.00 = Always Encountered

Level of Adoption of Safe Pesticide Use

The adoption of safe pesticide use practices reflects how well farmers integrate recommended strategies into their farming systems. These practices include compliance with government regulations, application of alternative pest management methods, and participation in training or community initiatives that promote pesticide safety. Assessing the level of adoption is important because it provides insights into the extent to which farmers are embracing safer and more sustainable approaches, while also identifying areas where further support and capacity-building are needed. The results in Table 6 present the level of adoption of safe pesticide use among farmer respondents.

Table 6 presents the farmers' level of adoption of safe pesticide practices, with an overall mean of 3.21, interpreted as "Fairly Adopted." Respondents showed moderate commitment to strategies such as reducing pesticide use, attending trainings, and supporting community initiatives. However, full adoption remains limited, with room for improvement in consistent participation and knowledge-sharing.

While programs such as the Good Agricultural Practices (GAP) and the Pesticide Safety Awareness Program (PSAP) exist, their limited reach and enforcement reduce their effectiveness. Field observations suggest that economic concerns, time limitations, and lack of trust in non-chemical methods hinder full adoption.

Coulibaly et al. (2022) confirms that access to training and financial support greatly influences adoption. Thammachai et al. (2022) note that awareness of long-term health and environmental benefits promotes commitment to safe practices.

Table 6

Level of Adoption of Pesticide Use of Farmers' Respondents

Statement	Mean	Standard Deviation	Verbal Interpretation
1. Strictly following government regulations on pesticide use.	3.280	0.867	Fairly Adopted
2. Applying alternative pest management strategies, such as	3.170	0.897	Fairly Adopted

organic pesticides or crop rotation.			
3. Reducing pesticide use in favor of safer methods.	3.260	0.953	Fairly Adopted
4. Actively sharing knowledge on safe pesticide use with fellow farmers.	3.060	0.849	Fairly Adopted
5. Willingness to attend further training on pesticide safety and alternatives	3.230	0.915	Fairly Adopted
6. Integrating biological pest control methods into farming practices.	3.190	0.941	Fairly Adopted
7. Using pesticide rotation strategies to minimize pest resistance.	3.200	0.910	Fairly Adopted
8. Following recommendations from agricultural experts before pesticide application..	3.120	0.936	Fairly Adopted
9. Supporting community initiatives on safe pesticide use.	3.280	0.848	Fairly Adopted
10. Participating in government or NGO-led pesticide safety programs.	3.230	0.874	Fairly Adopted
Overall Mean	**3.205**	**0.451**	**Fairly Adopted**

Legend: 1.00–1.80 = Not Adopted, 1.81–2.60 = Slightly Adopted, 2.61–3.40 = Fairly Adopted, 3.41–4.20 = Moderately Adopted, 4.21–5.00 = Highly Adopted

Association between Demographics and Pesticide Practices

The analysis of associations between demographic characteristics and pesticide practices revealed both significant and non-significant relationships. As shown in Table 7, household size was significantly associated with disposal practices and the level of adoption of safe pesticide use, while sources of income had a significant association with handling practices. These results imply that family size and income streams may directly influence how farmers manage pesticide-related tasks, either through shared household responsibilities or financial capacity to adopt safer practices. On the other hand, Table 8 presents the demographic factors that did not show any significant association with pesticide practices. Educational attainment, tenurial status, and farming experience were not found to be strong predictors of pesticide behavior. This suggests that while basic demographics provide some context, the more decisive factors shaping farmers' pesticide use may be their access to resources, availability of training, and exposure to agricultural extension services.

Significant Associations

Table 7 reveals significant associations between household size and both disposal practices (r^2 = 42.30) and adoption of safe pesticide use (r^2 = 62.32). Larger households may facilitate safer practices through shared labor and knowledge. Similarly, income diversity significantly affected handling practices (r^2 = 56.15), indicating that farmers with alternative income sources may invest more in safety tools and practices.

Table 7

Summary of Association between Demographics and Pesticide Practices

Demographic Variable	Pesticide Variable	r^2 Value	p Value	Decision	Verbal Interpretation
Household Size	Current Practices – Disposal	42.30	0.012	Reject	Significant
Household Size	Level of Adoption of Safe Use	62.32	0.036	Reject	Significant
Sources of Income	Current Practices – Handling	56.15	0.001	Reject	Significant

Non-Significant Associations

Table 8 shows non-significant associations between educational attainment, tenurial status, and farming experience with any pesticide behavior variable. This suggests that while demographic characteristics are important, access to resources and extension services plays a larger role in influencing behavior.

Table 8

Summary of Non-Significant Associations Between Demographics and Pesticide Practices

Demographic Variable	Pesticide Safety and Practices	Interpretation
Educational Attainment	No significant association with any variable	Education alone not predictive
Tenurial Status	No significant association with any variable	Tenure does not impact practices
Farming Experience	No significant association with any variable	Experience alone not influential

Conclusions

This study comprehensively addressed five key objectives concerning pesticide use among rice farmers in the Third District of Bulacan. First, with regard to the socio-demographic profile of the farmers, findings revealed that the majority of the 376 respondents were male, married, aged between 55–64 years, and had attained only elementary-level education. Most lived in households with 4–6 members, relied primarily on farming as their main income source, were tenants rather than landowners, and had between 11–20 years of farming experience, indicating an experienced but aging agricultural workforce with limited formal education.

Second, when assessing the farmers' awareness and practices concerning the safe use of pesticides, the results showed that farmers were only slightly aware of safety guidelines. Although some familiarity existed in reading pesticide labels and recognizing health risks, awareness remained low in essential areas such as applying the correct dosage, wearing appropriate protective equipment (PPE), and safely storing and disposing of pesticide containers. Correspondingly, practices were categorized as "sometimes practiced," reflecting inconsistencies between knowledge and application.

Third, the study identified that farmers sometimes encountered challenges in the application and handling of pesticides. These challenges included difficulty in determining the proper dosage, lack of consistent PPE usage, insufficient knowledge of proper storage and disposal, and limited understanding of government regulations. Among all areas, improper disposal emerged as the most significant concern, pointing to systemic issues such as lack of training, poor access to disposal infrastructure, and weak enforcement mechanisms.

Fourth, when evaluating the extent to which pesticide safety guidelines have been adopted, the findings indicated that these practices were only fairly adopted. Farmers expressed willingness to participate in training and reduce pesticide use, but actual implementation of safety practices was partial and inconsistent. Adoption was hindered by economic limitations, lack of institutional support, and skepticism regarding alternative pest control methods.

Fifth, the analysis of the relationship between socio-demographic characteristics and pesticide-related awareness, practices, and adoption revealed that household size was significantly associated with better disposal practices and overall adoption of safe pesticide use. Additionally, having multiple sources of income was significantly associated with improved handling practices, possibly due to better access to safety resources. In contrast, factors such as age, sex, educational attainment, farming experience, and

land tenure did not show a significant association, suggesting that individual traits alone do not determine pesticide safety behavior. Instead, collective household dynamics and financial flexibility appear to be more influential.

In summary, while the farmers in the study area showed limited awareness and inconsistent application of safe pesticide practices, the results highlight the critical influence of systemic, household-level, and economic factors over individual demographic traits. These findings call for targeted, inclusive interventions to close the gap between awareness and behavior and ensure safer pesticide use in agricultural communities.

Recommendations

Based on the study's findings, it is recommended that interventions prioritize improving pesticide disposal practices, as this parameter showed the lowest level of implementation among farmers. Establishing barangay-level disposal facilities and conducting intensive education on proper disposal methods—such as triple rinsing, puncturing, and avoiding reuse of containers—are critical. Since household size was found to be significantly associated with better disposal practices and higher adoption levels of safe pesticide use, training programs should involve entire farming households rather than focusing solely on individual farmers.. Engaging all household members can help reinforce shared responsibility and safer collective practices. Moreover, the significant association between sources of income and handling practices suggests that farmers with limited financial resources may face barriers to acquiring personal protective equipment (PPE).

Therefore, local government units (LGUs), cooperatives, or NGOs should provide PPE support through subsidies or free distribution programs. Training sessions must also be redesigned to focus specifically on weak areas—particularly safe pesticide disposal and handling—and should be delivered in simple, practical formats suited to the community's context. Since age, sex, education, and farming experience were not significantly related to safe pesticide practices, program planners should avoid assuming these traits predict safety behavior. Instead, efforts should center on accessible training, economic support, and household-level engagement. Additionally, peer-led demonstration farms and community model farmers can help promote proper practices through relatable, practical examples. Finally, further research should be conducted to investigate the behavioral and systemic barriers preventing farmers from consistently applying safe pesticide practices, despite having some level of awareness. This understanding is essential to designing effective, sustainable interventions.

Future research should focus on evaluating the long-term effects of interventions on pesticide practices through longitudinal studies and exploring farmers' underlying beliefs and barriers to adoption using qualitative approaches such as interviews and focus group discussions. It is also important to assess the effectiveness of existing programs, including Good Agricultural Practices (GAP) and the Pesticide Safety Awareness Program (PSAP), in influencing behavioral change. Expanding research across multiple regions will allow for meaningful comparisons of farming contexts and provide stronger evidence to guide national policy-making. Finally, examining the role of local institutions and cooperative models in promoting safe pesticide practices can help identify sustainable, community-driven strategies to support farmers in adopting and maintaining safer practices.

References

Ahmed, H. H., Astatike, H., Mekonen, S., et al. (2024). Analyzing Factors Affecting Farmers' Safe Pesticide Handling Practices in Southwest of Ethiopia: Implications for Policy. *Environmental Health Insights*, *18*. https://doi.org/10.1177/11786302241256495

Chouaïbou M. S., Fodjo B. K., Fokou G., Allassane O. F., Koudou B. G., David J. P., Antonio-Nkondjio C., Ranson H., Bonfoh B. (2016). Influence of the agrochemicals used for rice and vegetable cultivation on insecticide resistance in malaria vectors in southern Côte d'Ivoire. Malar J., 15(1):426. https://doi.org/10.1186/s12936-016-1481-5

Coulibaly, T. P., Du, J., & Diakité, D. (2022). Sustainable agricultural practices adoption. *Agriculture (Pol'nohospodárstvo)*, *67*(4), 166–176. https://doi.org/10.2478/agri-2021-0015

Damalas, C. A., & Koutroubas, S. D. (2017). Farmers' training on pesticide use is associated with elevated safety behavior. *Toxics*, *5*(3), 19. https://doi.org/10.3390/toxics5030019

Del Prado-Lu, J. L. (2010). Multipesticide residue assessment of agricultural soil and water in major farming areas in Benguet, Philippines. *Archives of Environmental Contamination and Toxicology*, *59*(2), 175–181. https://doi.org/10.1007/s00244-010-9478-5

Del Prado-Lu, J. L. (2015). Insecticide residues in soil, water, and eggplant fruits and farmers' health effects due to exposure to pesticides. *Environmental Health and Preventive Medicine, 20*(1), 53–62. https://doi.org/10.1007/s12199-014-0425-3

Department of Agriculture. (2021, September 7). Agri chief advocates balanced pesticides use strategy for food safety and security [Press release]. Department of Agriculture – Republic of the Philippines. https://www.da.gov.ph/agri-chief-advocates-balanced-pesticides-use-strategy-for-food-safety-and-security/

Desye, B., Tesfaye, A. H., Daba, C., Alemseged, E. A., 5, Angaw, Y., Ebrahim, A. M., Natnael, T., Hassen, S. & Woretaw, L., (2024). Pesticide safe use practice and acute health symptoms, and associated factors among farmers in developing countries: A systematic review and meta-analysis of an epidemiological evidence. *BMC Public Health, 24*, 3313. https://doi.org/10.1186/s12889-024-20817-x

Dhillon, R., & Moncur, Q. (2023). Small-scale farming: A review of challenges and potential opportunities offered by technological advancements. *Sustainability*, *15*(21), 15478. https://doi.org/10.3390/su152115478

Fertilizer and Pesticide Authority. (2020). *Pesticide regulatory policies and implementing guidelines*. https://fpa.da.gov.ph/fpa-green-book/

Food and Agriculture Organization of the United Nations. (2022). *World food and agriculture – statistical yearbook 2022*. FAO. https://doi.org/10.4060/cc2211en

Gupta, A. (2023). The Application of pesticides: Balancing agricultural needs and environmental concerns. *Journal of Agriculture. 6(4), 100–102.* https://doi.org/10.37532/ jagri.2023.6(4).100-102

Horgan, F. G., Mundaca, E. A., Hadi, B. A. R., & Crisol-Martínez, E. (2023). Diversified rice farms with vegetable plots and flower strips are associated with fewer pesticide applications in the Philippines. *Insects*, *14*(10), 778. https://doi.org/10.3390/insects14100778

Ichwandiani, R. & Hassan, S.H., (2025). Industrial analysis: Agriculture in Philippines. ASEAN research center: Business case study series. https://asb.edu.my/wp-content/uploads/2025/02/BCS010-Agriculture-in-the-Phillippines.pdf

Keleb, A., Ademas, A., Abebe, M., Berihun, G., Desye, B., & Bezie, A. E. (2024). Knowledge of health risks, safety practices, acute pesticide poisoning, and associated factors among farmers in rural irrigation areas of northeastern Ethiopia. *Front. Public Health. 12*, 1474487.

https://doi.org/10.3389/fpubh.2024.1474487

Kumar, V., Kumar, R., Singh, J. and Kumar, P. (2019) Contaminants in agriculture and environment: health risks and remediation. *Agriculture and Environmental Science, India*. https://doi.org/10.26832/AESA-2019-CAE

Lu, J. L., & Salas, E. K. (2021). Occupational risk exposures and adverse health findings among farmers in southern Philippines. *Acta Media Philippina,* 55(6). https://doi.org/10.47895/amp.v55i6.3244

Lu, J. L., Cosca, K. Z., & Del Mundo, J. (2010). Trends of pesticide exposure and related cases in the Philippines. *Journal of Rural Medicine, 5*(2), 153–164. https://doi.org/10.2185/jrm.5.153

Maddah, D., Ghach, W., Abi Farraj, N., Yehya, M., Al Khatib, J., & Alami, N. H. (2020). The first community-based intervention to promote safe pesticide use by developing knowledge, attitudes, and practices among Lebanese farmers. *Human and Ecological Risk Assessment: An International Journal*, *26*(10), 2824–2835. https://doi.org/10.1080/10807039.2019.1688639

Maienfisch P., & Koerber K. (2024). Recent innovations in crop protection research. *Pest Management Science, 81*(5), 2406–2418. https://doi.org/10.1002/ps.8441

McLain, R. (2023). Drivers and consequences of tenure security and mechanisms for enhancing tenure security. A synthesis on cigar research on tenure security (2013-2020). *International Food Policy Research Institute*. https://doi.org/10.2499/9780896294509

Nayak, P. & Solanki, H. (2021). Pesticides and Indian agriculture – A review*. International Journal of Research – Granthaalayah,* 9(5), 250–263. https://doi.org/10.29121/granthaalayah.v9.i5.2021.3930

Philippine Statistics Authority. (2023). *Special Release: Palay production in Bulacan, 2022*. https://rsso03.psa.gov.ph/sites/default/files/SRRN-2023-07-Palay-Production-in-Bulacan-2022.pdf

Sharifzadeh, M. S., Abdollahzadeh, G., Damalas, C. A., Rezaei, R., & Ahmadyousefi, M. (2019). Determinants of pesticide safety behavior among Iranian rice farmers. *Science of the Total Environment, 651*, 2953–2960. https://doi.org/10.1016/j.scitotenv.2018.10.179

Taber, K. S. (2018). The use of Cronbach's alpha when developing and reporting research instruments in science education. *Research in Science Education, 48*, 1273–1296. https://doi.org/10.1007/s11165-016-9602-2

Thammachai, A., Sapbamrer, R., Rohitrattana, J., Tongprasert, S., Hongsibsong, S., & Wangsan, K. (2022). Differences in knowledge, awareness, practice, and health symptoms in farmers who applied organophosphates and pyrethroids on farms. *Front. Public Health, 10*, 802810. https://doi.org/10.3389/fpubh.2022.802810

Tudi, M., Daniel Ruan, H., Wang, L., Lyu, J., Sadler, R., Connell, D., & Chu, C. (2021). Agriculture development, pesticide application and its impact on the environment. *International Journal of Environmental Research and Public Health*, *18*(3), 1112. https://doi.org/10.3390/ijerph18031112

Van T., Tan, D. K. Y., Cook, B. R., Liu, D. L., Cross, R., Tran, T. A., Utomo, A., Yous, S., Grunbuhel, C., & Cowie, A. (2024). *Smallholder farmers' challenges and opportunities: Implications for agricultural production, environment and food security. Journal of Environmental Management, 370*, 122536. https://doi.org/10.1016/j.jenvman.2024.122536

Yuan, Y., & Sun, Y. (2024). Practices, challenges, and future of digital transformation in smallholder

agriculture: Insights from a Literature Review. *Agriculture*, *14*(12), 2193. https://doi.org/10.3390/agriculture14122193

Zhao, R., Wang, H. H., Gao, J., Zhang, Y. J., Li, X., Zhou, J. J., Liang, P., Gao, X. W., & Gu, S. H. (2022). Plant volatile compound methyl benzoate is highly effective against *Spodoptera frugiperda* and safe to non-target organisms as an eco-friendly botanical-insecticide. *Ecotoxicology and Environmental Safety*, *245*, 114101. https://doi.org/10.1016/j.ecoenv.2022.114101