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PEST MANAGEMENT STRATEGIES OF RICE FARMERS IN THE SELECTED MUNICIPALITIES OF BUKIDNON, PHILIPPINES

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Abstract

Rice farmers in Bukidnon face challenges related to pests, which affect their yields. This study aimed to examine the pest management strategies of rice farmers in selected municipalities in Bukidnon. A descriptive research design was used, with data collected from 450 rice farmers in Malaybalay City, Maramag, and San Fernando. A stratified random sampling technique was used, and data were analyzed using descriptive numerical measures. To verify and validate the results of the quantitative analysis, a Focus Group Discussion (FGD) was also conducted with selected participants from the study areas. Results show that farmers are between 50 and 69 years old (59%), primarily male (66%), and have completed only up to high school level of education (36%). They are typically self-employed (64%) and manage small households (40%). Regarding pest management, rice farmers in Bukidnon primarily rely on traditional pest and disease identification methods, such as field monitoring and visual inspections. The most common pest and disease management strategies adopted by rice farmer respondents are cultural control, physical control, and Integrated Pest Management (IPM), with IPM being the most widely adopted strategy. This highlights the need to amplify training programs that teach farmers about IPM practices. By making resources and education more accessible, farmers can gain the knowledge and tools they need to implement more effective strategies, which would not only help increase their yields but also reduce crop losses in the long run.

Introduction

Rice (*Oryza sativa*) is a staple crop that nourishes two-thirds of the global population (Sen, Chakraborty, & Kalita, 2020) and has been recognized twice by the United Nations for its role in food security (Haggblade, Me-Nsope, & Staatz, 2017). Over half the world's population relies on rice, with global production projected to reach up to 567 million tons by 2030, highlighting the need to enhance yield and quality (Mohidem et al., 2022). In the Philippines, rice remains vital as a staple food and income source for many Filipinos (Casinillo, Rebojo, & Dargantes, 2023), contributing significantly to agriculture's gross value added and employing millions, especially in regions like Mindanao, which supports around 221,000 rice-related jobs (Digal & Balgos, 2016). However, rising production costs, cheaper imports, and declining farmer interest challenge local rice production despite advancements in varieties and farming practices (Diva et al., 2019). In Bukidnon, a major agricultural area in Mindanao, rice farming is crucial for both the local economy and food supply. Known as the “food basket” of Mindanao, Bukidnon is a leading producer of rice in the region (Guia, 2012). The high levels of pest infestations are a major contributor to the challenges faced in rice production in Bukidnon. Rice production is threatened by a high prevalence of pest infestations, particularly from pests such as the rice stem borer and brown plant hopper, which can cause significant yield losses if left unmanaged (Fahad, Nie, & Hussain, 2015). These challenges show that to maintain productivity and sustain food security, effective pest management strategies are needed.

This research addresses the pressing need to investigate the prevailing pest management strategies employed by rice farmers in Bukidnon.

Objectives

The main objective of this research was to determine the pest management strategies employed by rice farmers in selected municipalities of Bukidnon, Philippines. Specifically, the study also aimed to (1) describe the pest identification practices of farmers, and (2) determine the level of adoption of various pest control strategies.

Significance of the Study

The Department of Agriculture, through the respective City/Municipal Agriculture Offices, can use the results of the study as a basis to formulate interventions to encourage rice farmers to diversify and adopt effective and efficient pest management practices to reduce damages and to increase yield. The Local Government Units (LGUs) can also use the results of the study as a basis for prioritizing their projects to help address and find potential solutions to the challenges and problems encountered by rice farmers. In addition, policymakers can gain useful insights that can guide programs and policies aimed at supporting farmers and promoting sustainable farming. Lastly, it adds to academic knowledge and can inspire further research on effective and sustainable agricultural practices.

Limitations of the Study

This study focused on rice farmers in the municipalities of Maramag, San Fernando and Malaybalay City, in Bukidnon. This specifically covered lowland rice fields, as data for these areas was available, allowing for an in-depth analysis of pest and disease management practices in these settings. The responses regarding the identification of pest and disease management strategies by rice farmers were based on their perceptions, personal experiences, and current practices. Data was gathered from February to March 2025.

METHODOLOGY

A descriptive research design was used in the study. The locale of the study was at Malaybalay City, Maramag, and San Fernando in Bukidnon. The sampling frame was derived from the local City/Municipal Agriculture Offices of Maramag, Malaybalay City, and San Fernando, Bukidnon. The total population of registered rice farmers in these municipalities was 8,166. The researcher used the Cochran formula to determine the ideal sample size. Out of 524 identified rice farmers, 450 farmers participated in the study. Stratified random sampling was used to proportionately select the participants among the three locations.

The research instrument for this study included a cover letter, an informed consent form, and the main questionnaire. Initially, all content was written in English and then translated into

Cebuano by the researcher to facilitate data collection. The questionnaire commenced with a concise introduction, followed by clear instructions to guide farmers before they began answering the questions. The primary research tool was a self-constructed questionnaire designed to gather quantitative data on farmers' practices and experiences related to pest and disease management. It was validated by technical experts. They carefully reviewed each question, focusing on the accuracy of technical terms and ensuring the language was clear and easy to understand. The survey questionnaire was also subjected to pilot testing and reliability test with a Cronbach's Alpha value of 0.702, indicating a moderate level of reliability, meaning the questionnaire items are relatively consistent in measuring the intended information.

Before data collection, the necessary permissions were obtained from local authorities, including the City or Municipal Mayors and Agriculture Offices of Malaybalay City, Maramag, and San Fernando. An Institutional Ethics Review Committee (IERC) permit was also secured from Central Mindanao University (CMU) to ensure the study complied with ethical standards. Descriptive measures, particularly the mean, were used to analyze the data. Focus Group Discussion (FGD) was conducted to triangulate the survey results. A subset of rice farmers and pertinent barangay authorities were asked to provide their perspectives and validate the results. The researcher treated each participant with honesty, respect, and compassion throughout the whole study process, making sure that their rights, privacy, and general well-being were given priority. Strict adherence to ethical principles was maintained, including open and honest communication, voluntary participation, and safe handling of all data gathered.

RESULTS AND DISCUSSIONS

Pest and Disease Identification Strategies

Table 1 shows the pest and disease identification strategies of rice farmer respondents in selected municipalities of Bukidnon regarding their pest and disease identification strategies. The highest-rated strategy is the regular monitoring of rice fields for signs of pests (m = 4.70), indicating it is very highly implemented. It is then followed by identifying pests based on visual symptoms (m = 4.31), monitoring weather patterns to predict outbreaks (m = 4.19), and performing detailed inspections (m = 4.02), all reflecting high implementation. In contrast, the lowest-rated

strategy is using digital tools or apps for pest identification (m = 1.42), reflecting very low implementation. The overall mean (m= 3.24) suggests that, on average, the strategies are moderately implemented.

Table 1. Pest and disease identification strategies of rice farmer respondents in selected municipalities of Bukidnon

INDICATORS	WEIGHTED MEAN	QUALITATIVE INTERPRETATION
I regularly monitor my rice field for signs of pests.	4.70	Very Highly Implemented
I identify pests based on visual symptoms on my rice plants.	4.31	Highly Implemented
I monitor weather patterns to help predict potential pest outbreaks in my rice field.	4.19	Highly Implemented
I perform detailed inspections of affected rice plants to confirm the type of pest.	4.02	Highly Implemented
I use forecasting tools or models to anticipate pest occurrences in my rice field.	3.91	Highly Implemented
I consult reference materials (e.g., books, manuals, online resources) to help identify pests.	2.88	Moderately Implemented
I rely on feedback from fellow farmers to identify pests in my rice field.	2.76	Moderately Implemented
I rely on advice from agricultural extension workers to identify pests in my rice field, such as AEW, DA, and Agricultural Extension Workers.	2.54	Moderately Implemented
I use pest traps (e.g., light traps, pheromone traps) to identify and monitor pest populations in my rice field as part of pest and disease identification strategies.	1.61	Low Implementation
I use digital tools or apps for pest and disease identification in my rice field.	1.42	Very Low Implementation
Overall Mean	3.24	Moderately Implemented

Legend:

Scale	Range	Descriptive Rating	Qualitative Interpretation
5	4.51-5.00	Always	Very Highly Implemented
4	3.51-4.50	Often	Highly Implemented
3	2.51-3.50	Sometimes	Moderately Implemented
2	1.51-2.50	Rarely	Low Implementation
1	1.00-1.50	Never	Very Low Implementation

This finding aligns with similar studies that suggest many smallholder farmers, especially in rural areas, tend to rely on traditional, hands-on methods such as visual inspection and weather pattern monitoring to identify pests. These practices are common among farmers in various regions of Southeast Asia and Sub-Saharan Africa, where limited access to digital tools and resources restricts the adoption of more modern technologies (Baffes et al., 2019). However, some studies report that farmers in more technologically advanced regions are increasingly turning to digital tools and pest traps, which highlights a gap in the adoption of these strategies in less-resourced areas like the Bukidnon municipalities (Fofana et al., 2020). This contrast between different regions underscores the varying rates of technological adoption and the challenges that hinder the broader implementation of innovative pest management techniques.

The reasons behind the moderate use of pest identification strategies in Bukidnon can be linked to several socio-economic factors. During the conduct of the Focus Group Discussions (FGDs), it was highlighted that rice farmers do regular inspections in the field for the presence of pests in the rice farms. Farmers' reliance on traditional methods like visual inspection and weather monitoring is likely due to limited access to advanced pest management tools, such as digital apps and pest traps. Financial constraints and lack of training in modern agricultural technologies are significant barriers, as indicated by Fofana et al. (2020), who noted that smallholder farmers in sub-Saharan Africa face similar obstacles. Moreover, while farmers in Bukidnon have access to agricultural extension services, their reliance on peer advice and reference materials for pest identification suggests that they may lack the resources or incentives to fully embrace new technological solutions. This reliance on community-based knowledge sharing aligns with findings by Mignouna et al. (2020), who emphasize the importance of peer learning and extension services in improving agricultural practices in rural communities.

The implications of these findings are significant for the future of pest management in Bukidnon's rice farming sector. While traditional methods of pest identification, such as visual

monitoring and weather pattern tracking, remain essential, the limited use of modern tools like digital apps and pest traps could hinder long-term improvements in pest management. The integration of innovative technologies could enhance early detection and more precise pest control, leading to better crop yields and reduced pesticide usage. As Rola et al. (2017) suggest, investing in digital tools and enhancing farmers' access to training in modern pest management strategies could increase the adoption of these advanced techniques. Such initiatives could also strengthen the role of agricultural extension services and improve collaboration among farmers, extension workers, and technology developers, ultimately fostering a more sustainable and resilient rice farming system in the region.

Pest and Disease Management Strategies

The study assessed the adoption levels of various pest and disease management strategies among rice farmer respondents, focusing on biological control, mechanical control, cultural control, physical control, chemical control, and Integrated Pest Management (IPM).

Adoption of Chemical Control Practices

Table 2 shows the extent of adoption of chemical control practices by rice farmer respondents in selected municipalities of Bukidnon. The highest-rated practices are the application of herbicides (m = 4.90), the use of synthetic pesticides (m = 4.87), and the regular application of insecticides (m = 4.83), all indicating very high adoption. In contrast, the lowest-rated practice is using growth regulators, such as gibberellins or auxins (m = 1.47), reflecting very low adoption. The overall mean (m= 3.97) indicates high adoption of chemical control practices.

Table 2. Extent of adoption of chemical control practices by rice farmer respondents in selected municipalities of Bukidnon

INDICATORS	WEIGHTED MEAN	QUALITATIVE INTERPRETATION
I apply herbicides to manage weeds in my rice field.	4.90	Very High Adoption

I use synthetic pesticides to control pests in my rice field.	4.87	Very High Adoption
I regularly apply insecticides to reduce pest populations in my rice field.	4.83	Very High Adoption
I use fungicides to prevent diseases in my rice field.	4.70	Very High Adoption
I follow the recommended pesticide application rates and timings in my rice field.	4.43	High Adoption
I use chemicals as a last resort in controlling pest in my rice field.	4.35	High Adoption
I keep records of pesticide applications and their effectiveness in my rice field.	4.10	High Adoption
I seek advice from agricultural professionals about chemical control in my rice field.	3.04	Moderate Adoption
I use acaricides to control mite populations in my rice field.	2.96	Moderate Adoption
I use growth regulators, such as gibberellins, auxins, or plant growth inhibitors, to manage pest-related issues in my rice field.	1.47	Very Low Adoption
Overall Mean	3.97	High Adoption

Legend:

Scale	Range	Descriptive Rating	Qualitative Interpretation
5	4.51-5.00	Always	Very High Adoption
4	3.51-4.50	Often	High Adoption
3	2.51-3.50	Sometimes	Moderate Adoption
2	1.51-2.50	Rarely	Low Adoption
1	1.00-1.50	Never	Very Low Adoption

In developing countries, especially in Asia, the reliance on chemical control practices has been widespread, particularly due to the urgency of addressing pest infestations and the perceived immediacy of chemical solutions (Thapa et al., 2018). The widespread use of pesticides and herbicides in rice farming has become a common practice in areas where crop yields are highly

vulnerable to pest and weed threats, highlighting a global trend of chemical dependency in agriculture. This high adoption rate in Bukidnon is consistent with these trends, suggesting that chemical control is a go-to method for pest management in the region.

The reasons behind the high adoption of chemical control practices can be attributed to several factors. First, the accessibility and effectiveness of chemical pesticides, herbicides, and insecticides make them a preferred choice for farmers facing frequent pest and weed outbreaks. According to Thapa et al. (2018), farmers in developing countries often resort to chemicals because they are perceived as an effective and relatively low-cost solution to managing pests and diseases. However, this widespread use raises concerns about sustainability and potential long-term negative effects on the environment. Studies such as those by Ocampo et al. (2020) in the Philippines reveal that many farmers lack the necessary expertise to apply pesticides responsibly, which can lead to improper usage and the emergence of pesticide-resistant pests. Furthermore, Meena et al. (2021) highlight that despite the immediate success of chemical control, the environmental consequences, including soil degradation and the contamination of water resources, remain significant challenges. This over-reliance on chemicals without proper knowledge or safeguards can lead to diminished agricultural productivity over time.

The implications of these findings are significant for the future of rice farming in Bukidnon. While chemical control practices can provide short-term relief from pests, the long-term sustainability of rice production could be jeopardized if these practices are not carefully managed. As Davis et al. (2017) emphasized, agricultural extension services play a critical role in ensuring that farmers are properly educated on the safe and responsible use of chemicals, as well as the exploration of alternative pest control methods. Encouraging the adoption of integrated pest management (IPM) strategies, which combine chemical, biological, and cultural control methods, could reduce the environmental risks influenced with excessive pesticide use. Furthermore, promoting the use of organic pesticides and other eco-friendly alternatives could enhance sustainability in rice farming.

Adoption of Biological Control Practices

Table 3 shows the extent of adoption of biological control practices by rice farmer respondents in selected municipalities of Bukidnon. The highest-rated practice is preserving natural enemies, such as spiders and predatory beetles (m = 2.94), reflecting moderate adoption. In contrast, the lowest-rated practices are introducing entomopathogenic biocontrol agents (e.g., Trichoderma) to control diseases (m = 1.27) and introducing parasitoid insects (e.g., Trichogramma) to control pests (m = 1.32), both indicating very low adoption. The overall mean (m= 1.95) suggests low adoption of biological control practices.

Table 3. Extent of adoption of biological control practices by rice farmer respondents in selected municipalities of Bukidnon

INDICATORS	WEIGHTED MEAN	QUALITATIVE INTERPRETATION
I preserve natural enemies, such as spiders and predatory beetles, in my rice field to help control pests.	2.94	Moderate Adoption
I collaborate with agricultural extensions for the application of biological control.	2.34	Low Adoption
I participate in workshops or training sessions on biological control techniques.	2.26	Low Adoption
I study pest life cycles to optimize biological control timing on my farm.	2.18	Low Adoption
I encourage biodiversity on my farm to enhance pest control.	2.11	Low Adoption
I evaluate the effectiveness of biological control methods.	1.99	Low Adoption
I use biocontrol agents systematically in my rice field.	1.67	Low Adoption
I introduce predatory insects (e.g lacewig, earwig, etc.) to control pests in my rice field.	1.42	Very Low Adoption
I introduce parasitoids insects (e.g Trichogramma)	1.32	Very Low Adoption

to control pests in my rice field.		
I introduce entomopathogenic BCAs (e.g., Trichoderma) to control diseases in my rice field.	1.27	Very Low Adoption
Overall Mean	1.95	Low Adoption

Legend:

Scale	Range	Descriptive Rating	Qualitative Interpretation
5	4.51-5.00	Always	Very High Adoption
4	3.51-4.50	Often	High Adoption
3	2.51-3.50	Sometimes	Moderate Adoption
2	1.51-2.50	Rarely	Low Adoption
1	1.00-1.50	Never	Very Low Adoption

This result is consistent with studies conducted in other agricultural regions, which show that while biological control is an eco-friendly and sustainable approach to pest management, its adoption remains limited, especially in smallholder farming systems. For instance, a study by Kantor et al. (2020) indicated that despite the known benefits of biological control, farmers often prioritize chemical solutions due to their perceived immediate effectiveness and familiarity. This pattern of low adoption of biological control in Bukidnon mirrors the struggles observed in other parts of the world, where traditional practices dominate, and new methods face slow uptake.

During the conduct of the Focus Group Discussions (FGDs), rice farmers mentioned that they are using beneficial insects that help reduce the population of pests in rice fields. However, they are not using biological control agents (BCAs) such as *Trichoderma* and *Trichogramma* due to their unavailability in the area. Farmers also noted that if such inputs become available, they would consult the nearest Municipal Agriculture Office for guidance. The reasons behind the low adoption of biological control practices can be attributed to several key factors. One major limitation is the lack of knowledge and technical support available to farmers. Sammons et al. (2016) argue that biological control agents require specific knowledge regarding their correct application and timing, which many farmers lack. Without adequate information or training, farmers are less likely to embrace such techniques, especially if they are uncertain about the effectiveness of biocontrol agents like parasitoids or predatory insects. Additionally, Seyoum et al. (2017) emphasize that the difficulty of integrating biological control into traditional agricultural systems also contributes to its limited use. Farmers often find it challenging to combine biological control methods with conventional practices, particularly when dealing with pests that are more

easily controlled through chemical means. Moreover, López et al. (2021) found that rice farmers rated improved biological pest management techniques, such as the introduction of biocontrol agents like Trichoderma, poorly, suggesting that while farmers may acknowledge the benefits, they still rely on more conventional methods.

The implications of these findings suggest that there is a need for greater investment in education and training programs to promote the adoption of biological control practices. Kantor et al. (2020) suggest that improving access to knowledge about biological pest management and providing technical assistance can help overcome some of the barriers to adoption. Furthermore, as farmers become more aware of the environmental and economic benefits of biological control, such as reducing pesticide resistance and promoting biodiversity, they may become more inclined to adopt these practices. Therefore, agricultural extension services must play a critical role in supporting farmers by providing practical demonstrations and guidance on integrating biological control methods into their farming systems. Encouraging the adoption of integrated pest management (IPM) strategies, which combine biological, cultural, and chemical controls, could provide a more sustainable and environmentally friendly approach to pest management in Bukidnon.

Adoption of Integrated Pest Management (IPM) Practices

Table 4 shows the extent of adoption of Integrated Pest Management (IPM) practices by rice farmer respondents in selected municipalities of Bukidnon. The highest-rated practices include regularly assessing the effectiveness of pest control methods (m = 4.19), regularly monitoring and identifying pest populations before acting (m = 3.97), and combining biological, cultural, and chemical methods to manage pests (m = 3.68), all indicating high adoption. In contrast, the lowest-rated practices are rotating rice planting with other crops to reduce pest and disease pressure (m = 1.69) and using trap crops to attract and manage pests (m = 1.75), both reflecting low adoption. The overall mean (m= 2.95) suggests moderate adoption of IPM practices.

Table 4. Extent of adoption of Integrated Pest Management (IPM) practices by rice farmer respondents in selected municipalities of Bukidnon

INDICATORS	WEIGHTED MEAN	QUALITATIVE INTERPRETATION
I regularly assess the effectiveness of pest control methods.	4.19	High Adoption
I regularly monitor and identify pest populations in my rice field before taking any pest control actions.	3.97	High Adoption
I combine biological, cultural, and chemical methods to manage pests.	3.68	High Adoption
I use soil management techniques to prevent pest/disease emergence.	3.34	Moderate Adoption
I consistently stay informed and refresh my knowledge on the latest pest management strategies.	2.98	Moderate Adoption
I utilize weather forecasts and pest prediction tools to help make informed decisions on pest management.	2.78	Moderate Adoption
I attend training sessions on the principles of IPM.	2.57	Moderate Adoption
I collaborate with other farmers to share IPM strategies.	2.57	Moderate Adoption
I use trap crops to attract and manage pest in my rice field.	1.75	Low Adoption
I rotate rice planting with other crops when feasible to reduce pest and disease pressure.	1.69	Low Adoption
Overall Mean	2.95	Moderate Adoption

Legend:

Scale	Range	Descriptive Rating	Qualitative Interpretation
5	4.51-5.00	Always	Very High Adoption
4	3.51-4.50	Often	High Adoption
3	2.51-3.50	Sometimes	Moderate Adoption
2	1.51-2.50	Rarely	Low Adoption
1	1.00-1.50	Never	Very Low Adoption

These findings align with research in other regions, such as Nandula et al. (2019), which demonstrated that when farmers use monitoring techniques, pest management outcomes improve. However, practices like crop rotation (m = 1.69) and trap cropping (m = 1.75) show low adoption in Bukidnon, mirroring a broader trend seen in other studies where more labor-intensive or knowledge-heavy strategies are often underutilized (Sengupta et al., 2018). This contrast suggests that while certain IPM elements are embraced, others face greater resistance or limitations, which is consistent with other research on IPM adoption in smallholder farming systems.

Several factors can explain why rice farmers in Bukidnon are more inclined to adopt some IPM practices over others. The key reasons often relate to the knowledge and resource requirements for successful implementation. For example, practices like pest monitoring and assessing pest control methods are easier to implement because they require fewer resources and can be done with basic tools and knowledge. These practices are consistent with the findings of Nandula et al. (2019), who found that farmers are more likely to adopt pest monitoring as part of IPM because it is perceived as cost-effective and less time-consuming. On the other hand, practices such as crop rotation or using trap crops require more investment in terms of knowledge, time, and sometimes even financial resources. According to Parsa et al. (2014), although integrated pest management (IPM) practices are beneficial for sustainable pest control, their adoption can be hindered by farmers' limited understanding of pest biology, crop ecology, and the need for technical support, particularly in developing countries. This may explain why such practices are rated poorly in Bukidnon, as they might not fit well within the daily practices of farmers who are more accustomed to conventional methods.

The implications of these findings are significant for promoting IPM in Bukidnon and similar regions. If farmers are to realize the full benefits of IPM, especially in terms of sustainability and long-term pest control, there is a need to encourage broader adoption of a more holistic set of practices.

As noted by Parsa et al. (2014), effective integrated pest management (IPM) requires a holistic approach that combines pest monitoring, biological control methods, and cultural practices such as crop rotation. To enhance adoption, it is essential to provide targeted training and continuous support through agricultural extension services. Equipping farmers with the necessary knowledge and tools to apply all components of IPM, especially knowledge-intensive practices

like crop rotation and trap cropping, can significantly improve their pest management strategies and outcomes. Moreover, emphasizing the environmental and economic benefits of these methods, such as reducing pesticide use and improving soil health, could incentivize more farmers to adopt these practices fully. As research has shown, the successful implementation of IPM can lead to higher yields, better pest control, and more sustainable farming practices (Nandula et al., 2019). Therefore, expanding IPM adoption in Bukidnon can lead to both immediate and long-term benefits for farmers, their communities, and the environment.

Adoption of Cultural Control Practices

Table 5 shows the extent of adoption of cultural control practices by rice farmer respondents in selected municipalities of Bukidnon. The highest-rated practice is following synchronous planting to avoid peak pest infestations (m = 4.54), indicating very high adoption. Other practices, such as selecting pest-resistant rice varieties (m = 4.24) and tracking pest occurrence patterns (m = 3.69), reflect high adoption. On the lower end, practices such as practicing intercropping for pest management (m = 1.53) and using mulching techniques to suppress weeds and pests (m = 2.38) indicate low adoption. The overall mean (m= 3.27) suggests moderate adoption of cultural control practices.

Table 5. Extent of adoption of cultural control practices by rice farmer respondents in selected municipalities of Bukidnon

INDICATORS	WEIGHTED MEAN	QUALITATIVE INTERPRETATION
I follow a synchronous planting to avoid the times when pest infestations peak.	4.54	Very High Adoption
I select pest-resistant rice varieties for planting.	4.24	High Adoption
I track the history of my rice field to identify pest occurrence patterns.	3.69	High Adoption
I remove and dispose of infected plants to prevent disease spread in my rice field.	3.48	Moderate Adoption
I maintain field hygiene by removing debris and crop residues.	3.71	High Adoption
I implement fallow periods to break pest cycles in my rice field.	3.28	Moderate Adoption
I educate farm workers about proper pest management practices.	2.97	Moderate Adoption
I participate in community clean-up initiatives to reduce pest habitats.	2.85	Moderate Adoption
I use mulching techniques to suppress weeds and pests in my rice field.	2.38	Low Adoption
I practice intercropping to enhance pest management in my rice field.	1.53	Low Adoption
Overall Mean	3.27	Moderate Adoption

Legend:

Scale	Range	Descriptive Rating	Qualitative Interpretation
5	4.51-5.00	Always	Very High Adoption
4	3.51-4.50	Often	High Adoption
3	2.51-3.50	Sometimes	Moderate Adoption
2	1.51-2.50	Rarely	Low Adoption
1	1.00-1.50	Never	Very Low Adoption

In the rice-growing municipalities of Bukidnon, farmers have adopted a range of cultural control practices to manage pests and diseases, but their choices reveal both similarities and differences when compared to other regions. Two practices that stand out in Bukidnon are synchronous planting (m = 4.54) and selecting pest-resistant rice varieties (m = 4.24), both of which are highly embraced by farmers. This aligns with trends seen in other agricultural studies. For example, Horgan et al. (2016) pointed out that synchronized planting is a popular method in various rice-growing areas, as it limits the window of pest infestation, reducing opportunities for pests to reproduce and spread. Similarly, Hashemi and Damalas (2015) found that Southeast Asian farmers widely adopt pest-resistant rice varieties to help mitigate damage caused by pests. However, when it comes to other cultural control practices, Bukidnon farmers seem to take a different approach. The adoption of intercropping (m = 1.53) and mulching (m = 2.38) is notably low, a contrast to findings in other regions where intercropping is considered an effective pest management strategy. In their study, Mishra et al. (2020) suggested that smallholder farmers often face challenges in adopting such methods due to labor shortages, lack of technical training, and the uncertain results these practices may yield. These factors could help explain why Bukidnon farmers have yet to fully embrace intercropping and mulching as pest management tools. The story of Bukidnon farmers reflects a blend of common practices and unique challenges that shape how pest control methods are adopted in the region.

During the conduct of the Focus Group Discussions (FGDs), participants shared that they regularly clean their rice farm equipment and maintain hygiene in the field. They do not practice intercropping due to limited land area devoted to rice, and mulching is not typically performed as it is not a common practice in rice farming. Synchronous planting and selecting pest-resistant rice varieties are both practices that require relatively less labor and investment, making them easier for farmers to implement. These strategies can be integrated into existing farming practices without requiring significant changes to the farming system. For instance, synchronous planting can be coordinated across fields with minimal cost and effort, as it primarily involves adjusting the planting time to align with pest life cycles (Horgan et al., 2016). Additionally, pest-resistant rice varieties are often promoted by agricultural extension services, making them more accessible and well-known among farmers. On the other hand, practices such as intercropping and mulching require more intensive labor and knowledge. These practices can be more time-consuming and

may not yield immediate, observable results, making them less appealing to farmers. Mishra et al. (2020) pointed out that smallholder farmers in many regions often perceive these practices as burdensome due to limited labor resources and lack of confidence in their effectiveness, which may also be contributing factors in Bukidnon.

The findings from this study have important implications for promoting cultural control practices in Bukidnon and similar regions. While practices like synchronous planting and selecting pest-resistant varieties are already well-adopted and effective, there is still significant room for improvement in the adoption of more labor-intensive strategies like intercropping and mulching. According to Horgan et al. (2016), enhancing the adoption of cultural control methods requires more than just introducing new practices—it involves addressing the constraints that farmers face, such as labor shortages, lack of knowledge, and resource limitations. Providing targeted education and training on the benefits of these practices, as well as demonstrating their long-term advantages for pest management and soil health, could help increase their adoption. Additionally, the promotion of integrated cultural practices, where farmers combine multiple strategies in a holistic approach, could lead to more sustainable pest management and improved crop yields. Ultimately, addressing the barriers to adopting more diverse cultural practices could help farmers in Bukidnon and beyond achieve better pest control with fewer chemicals, leading to more environmentally sustainable and cost-effective rice production.

Adoption of Mechanical Control Practices

Table 6 shows the extent of adoption of mechanical control strategies by rice farmer respondents in selected municipalities of Bukidnon. The highest-rated practice is cleaning equipment and tools to prevent pest transfer (m = 4.59), indicating very high adoption. Other high-adoption practices include manually removing weeds with tools (m = 4.49) and regularly inspecting and manually removing pests (m = 3.73). On the lower end, practices such as using pheromone traps to capture pests (m = 1.05) and using vacuums or mechanical tools to remove pests (m = 1.38) reflect very low adoption. The overall mean (m= 2.85) suggests moderate adoption of mechanical control strategies.

Table 6. Extent of adoption of mechanical control strategies by rice farmer respondents in selected municipalities of Bukidnon

INDICATORS	WEIGHTED MEAN	QUALITATIVE INTERPRETATION
I clean equipment and tools to prevent pest transfer.	4.59	Very High Adoption
I manually remove weeds using tools such as a bolo or hoe to prevent pest spread in my rice field.	4.49	High Adoption
I regularly inspect and manually remove pests from my rice field as part of mechanical control strategies.	3.73	High Adoption
I use water management strategies to control pest habitats in my rice field.	3.64	High Adoption
I handpick pests from plants in my rice field.	3.38	Moderate Adoption
I use mechanical tillage to disrupt pest life cycles in my rice field.	3.07	Moderate Adoption
I use physical barriers (e.g., nets, row covers) to protect crops in my rice field.	1.97	Low Adoption
I use vacuums or mechanical tools to remove pests from crops.	1.38	Very Low Adoption
I use traps (e.g., sticky traps) to monitor and control pests in my rice field.	1.19	Very Low Adoption
I use pheromone traps to capture and reduce pest populations in my rice field.	1.05	Very Low Adoption
Overall Mean	2.85	Moderate Adoption

Legend:

Scale	Range	Descriptive Rating	Qualitative Interpretation
5	4.51-5.00	Always	Very High Adoption
4	3.51-4.50	Often	High Adoption
3	2.51-3.50	Sometimes	Moderate Adoption
2	1.51-2.50	Rarely	Low Adoption
1	1.00-1.50	Never	Very Low Adoption

The adoption of mechanical control strategies by rice farmers in selected municipalities of Bukidnon reflects both traditional and modern pest management practices. The very high adoption of practices such as cleaning equipment and tools to prevent pest transfer (m = 4.59) and manually removing weeds with tools (m = 4.49) is consistent with findings from other studies, which highlight the continued reliance on manual and basic mechanical control methods. Horgan et al. (2016) observed that these traditional techniques are commonly used due to their affordability, ease of implementation, and minimal need for specialized skills or equipment. However, the results also show significant contrast when it comes to modern mechanical control tools, such as using pheromone traps (m = 1.05) or vacuums (m = 1.38), both of which are rated as having very low adoption. This underutilization of more sophisticated mechanical tools aligns with studies like Meena et al. (2021), who noted that despite their potential efficacy, modern mechanical control methods are often under-adopted by smallholder farmers due to high costs, limited accessibility, and lack of technical knowledge.

Several factors help explain the observed patterns in the adoption of mechanical control practices among Bukidnon's rice farmers. Practices such as manually removing weeds and cleaning tools are deeply ingrained in traditional farming systems, and their simplicity and low cost make them accessible even to resource-constrained farmers. According to Horgan et al. (2016), these methods do not require significant capital investment, making them ideal for farmers who may not have the financial capacity to invest in more expensive technological solutions. On the other hand, modern mechanical tools like pheromone traps and vacuums often come with high initial costs, ongoing maintenance expenses, and a steep learning curve, which may discourage farmers from adopting them. Meena et al. (2021) also found that smallholder farmers in many developing countries, including the Philippines, are less likely to adopt such high-tech methods due to insufficient knowledge, lack of training, and perceived inefficiency in comparison to traditional approaches. Furthermore, the limited availability of these modern tools in rural markets exacerbates the issue, making it difficult for farmers to access them even if they are willing to try.

The implications of these findings suggest that while Bukidnon rice farmers have made significant strides in adopting basic mechanical control methods, there is still a considerable gap in the adoption of advanced pest management tools. According to Kantor et al. (2020),

incorporating advanced mechanical strategies such as pheromone traps, mechanical vacuums, and physical barriers could further enhance the sustainability and effectiveness of pest management systems in rice fields. However, achieving widespread adoption of these modern tools will require addressing key barriers, including cost, accessibility, and the need for farmer education and training. To maximize the potential benefits of mechanical control methods, agricultural extension services should prioritize providing knowledge on the effective use of both traditional and modern strategies. This approach could help integrate mechanical control more comprehensively into Integrated Pest Management (IPM) systems, enhancing pest control while minimizing the use of chemical pesticides.

Adoption of Physical Control Practices

Table 7 shows the extent of adoption of physical control strategies by rice farmer respondents in selected municipalities of Bukidnon. The highest-rated practice is regularly inspecting and maintaining equipment to prevent the spread of pests (m = 4.69), indicating very high adoption. Other high-adoption practices include manually weeding the rice field (m = 4.11). On the lower end, practices such as using temperature control methods (m = 1.24) and light traps to attract and kill pests (m = 1.38) reflect very low adoption. The overall mean (m= 2.55) suggests moderate adoption of physical control strategies.

Table 7. Extent of adoption of physical control strategies by rice farmer respondents in selected municipalities of Bukidnon

INDICATORS	WEIGHTED MEAN	QUALITATIVE INTERPRETATION
I regularly inspect and maintain my equipment to prevent the spread of pests in my rice field.	4.69	Very High Adoption
I manually weed my rice field to prevent weed competition.	4.11	High Adoption
I flood fields to control specific pests in my rice field.	3.50	Moderate Adoption
I apply mechanical tillage to disrupt pest breeding cycles in my rice field.	2.41	Low Adoption

I burn crop residues to eliminate pest habitats in my rice field.	2.35	Low Adoption
I use manual labor (e.g., hand-picking, pruning) to physically control pests and weeds in my rice field.	2.28	Low Adoption
I use windbreaks to protect my rice field from pest invasion.	1.86	Low Adoption
I use physical barriers like row covers or insect netting in my rice field.	1.67	Low Adoption
I use light traps to attract and kill pests in my rice field.	1.38	Very Low Adoption
I use temperature control methods (e.g., solarization) to manage pests.	1.24	Very Low Adoption
Overall Mean	2.55	Moderate Adoption

Legend:

Scale	Range	Descriptive Rating	Qualitative Interpretation
5	4.51-5.00	Always	Very High Adoption
4	3.51-4.50	Often	High Adoption
3	2.51-3.50	Sometimes	Moderate Adoption
2	1.51-2.50	Rarely	Low Adoption
1	1.00-1.50	Never	Very Low Adoption

The adoption of physical control strategies by rice farmers in Bukidnon, as presented in the study, shows a blend of traditional and modern pest management practices. The high adoption of practices such as regularly inspecting and maintaining equipment to prevent pest spread (m = 4.69) and manually weeding the rice field (m = 4.11) is consistent with findings from other studies on rice farming in Southeast Asia. For instance, a study by Nicolas and Cabarogias (2015) in Southeast Luzon, Philippines, highlighted that farmers rely on manual pest control techniques like burning rice straw and using natural predators, such as cats, to control rodents. Similarly, farmers in Bukidnon have demonstrated a strong commitment to traditional methods, particularly manual labor-based techniques. However, the very low adoption of practices such as using temperature control methods (e.g., solarization, m = 1.24) and light traps (m = 1.38) contradicts the findings of

a broader regional shift towards Integrated Pest Management (IPM), where physical control methods are encouraged to reduce pesticide use, as observed by Stuart et al. (2024). This contrast reveals that while there is some progress in adopting IPM, the full utilization of physical control methods remains limited in certain areas.

Several factors can explain why some physical control practices are more widely adopted than others. Manual practices like weeding and equipment maintenance are well-established, accessible, and require minimal investment in technology or specialized knowledge. According to Stuart et al. (2024), these practices align with local traditions and are more easily integrated into existing farming systems. On the other hand, practices like temperature control through solarization or using light traps are more technically demanding and require significant investment in equipment or infrastructure.

The implications of these findings suggest that while traditional physical control methods like manual weeding and equipment maintenance remain integral to pest management in Bukidnon, there is significant room for improvement in the adoption of more advanced physical control techniques. As IPM becomes increasingly popular in Southeast Asia, incorporating physical control methods such as light traps and solarization could further enhance pest management sustainability and effectiveness. According to Kantor et al. (2020), integrating these methods into IPM frameworks has the potential to reduce chemical pesticide use, minimize environmental damage, and improve long-term productivity. To encourage wider adoption of such techniques, agricultural extension services should focus on providing training, enhancing accessibility to necessary tools, and demonstrating the cost-effectiveness and environmental benefits of adopting modern physical control methods.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

In pest and disease identification, most rice farmer respondents use traditional methods at a moderate level. They rely on hands-on approaches like visual inspection and observing weather patterns. This is mainly because they have limited access to modern tools such as digital applications and pest traps. Their use of traditional methods also comes from farming practices passed down over time. Because of this, identifying pests and diseases may not always be accurate

or timely, which can affect how well they manage their rice.

There is only a moderate level of adoption of pest management strategies among the selected rice farmers in Bukidnon. Biological control is rarely used due to limited availability and knowledge. Integrated Pest Management (IPM) is used moderately, with farmers focusing on monitoring but not utilizing practices like crop rotation and trap cropping as much. Cultural control practices, such as synchronous planting and using pest-resistant varieties, are common, but labor-intensive methods like intercropping and mulching are less frequently used. Mechanical control practices are widely adopted, especially cleaning equipment and manually 128 removing weeds, but advanced tools like pheromone traps and vacuums are rarely used due to their unavailability in the area. Traditional physical control methods, such as weeding and maintaining equipment, are widely used, but methods like temperature control and light traps are underutilized, indicating the need for more training on these techniques.

Recommendations

Based on the experiences and challenges shared by rice farmers in Bukidnon, it is clear that they need more support to effectively manage pests and diseases in their fields. The following recommendations aim to help strengthen their practices and ensure that government and community efforts make a lasting difference in their lives:

1. Offer hands-on training on modern pest identification tools. Many farmers still rely on visual observation and experience when identifying pests and diseases. To help improve accuracy and timely response, practical training sessions should be organized on the use of modern tools like mobile apps and pest traps. These trainings should be easy to understand, use local language, and fit the realities of farmers' day-to-day routines;
2. Make pest identification tools more accessible to farmers. Even if modern tools exist, they are not always within reach of small-scale farmers. That is why government programs should provide these tools at little to no cost, especially to farmers in low-income areas. Giving them access to the right tools can go a long way in helping them protect their crops and reduce losses; and,
3. Combine traditional knowledge with modern approaches. Farmers have long used traditional ways to spot and deal with pests through keen observation, local remedies, and

years of experience. These practices should not be overlooked. Instead, they should be acknowledged and blended with scientific methods to create pest management strategies that are both effective and practical.

By putting these recommendations into action, rice farmers will be better equipped to handle the everyday challenges of managing pests. This will not just improve how they protect their rice, but it can also lead to optimal harvests and stronger rice farming areas in Bukidnon.

Conflicts of Interest

The authors have disclosed no conflicts of interest.

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