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# IPM technology adoption, preferences and conversion of annual and perennial crop growers in Southern Philippines for targeted extension program

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**Abstract** IPM adoption was prevalent in both annual (73 respondents) and perennial crop growers (42 respondents) in Southern Philippines after two years of participating in an IPM training program. Majority of the respondents (44 to 78%) adopted IPM at moderate level, adopting 25 to 50% of the technologies introduced in the program. Only annual crop growers (6 to 7%) showed very high IPM adoption level (>76% adopted technologies), particularly, rice and corn growers. Of the 64 technologies introduced, only four varied in terms of adoption among grower groups, while the rest of the technologies were adopted at the same level among grower groups. These four technologies were more preferred by perennial crop growers than annual crop growers. Perennial crop growers were 16%, 34%, 49% and 33% more to adopt technologies related to harvest and storage, antagonism, use of indigenous microorganisms (IMO), and agroforestry management, respectively, than annual crop growers. Majority of the respondents (>72%), who were identified as conventional pesticide users at the beginning of the program, converted as ETL-based pesticide users at the end of the program. Therefore, IPM adoption by annual and perennial crop growers is moderate to very high. Four technologies related to harvest and storage, antagonism, use of IMO, and agroforestry management vary among grower groups and preferred more by perennial crop growers. A high percentage conversion from conventional to ETL-based pesticide user is promoted with IPM training. Thus, in crafting IPM extension programs, it is vital to develop training designs that take into consideration these differences and preferences to promote sustainable IPM adoption.

**Keywords:** IPM adoption, Technology preference, Extension, IPM training, Training design

## Introduction

Integrated Pest Management (IPM) is a widely accepted concept in sustainable agriculture. This is the reason why many scientists, policymakers and agencies promote its use worldwide (Parsa *et al.*, 2014). IPM basically focuses on integrated application of multiple compatible technologies for safe,

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cost-effective and environmentally friendly pest management. Its practice revolves around the holistic approach or strategy for combating pests and diseases, while discouraging improper use of chemical pesticides (Stenberg, 2017).

IPM is often described using the IPM Pyramid with three general pyramidal tiers (bottom, middle and top) in which each tier includes crop protection strategies with certain similarities among each other, that are somewhat different from strategies in another tier (Stenberg, 2017). Briefly, the bottom tier includes strategies considered as abiotic actions which are encouraged to be applied most of the time during a growing season. The strategies in this tier include mechanical, physical, cultural, optic, and audative control practices. The middle tier, situated above the bottom tier, consists of practices considered as ecological which includes the biological control such as the use of predators and parasitoids. Finally, the top tier of the pyramid includes strategies on the proper and safe use of chemical pesticides which emphasize the use of economic threshold level (ETL) or action threshold to justify the use of these toxic substances as the last resort which should meet the requirement of necessity.

ETL is the pest population at which the application of pesticide as a last resort for pest control still will provide economic return to the grower (Stenberg, 2017). It signals the correct timing of pesticide application. Below ETL, strategies at the bottom and middle tier of the pyramid can suffice to control pest, while above ETL, the cost of control can exceed the economic return which equates to financial loss. Therefore, the use of an ETL keeps IPM abreast with the goals of sustainable agriculture despite the incorporation of pesticide use in the system.

In the Philippines alone, the Department of Agriculture is a prime agency implementing policies to develop and encourage the use of IPM which is heavily supported by various national and local agencies in the country. Despite the prominent theories and sound concepts and principles within its system, IPM still continues to suffer from anemic adoption in developing countries (Parsa *et al*., 2014) such as the Philippines. Various programs were implemented by various government agencies for adoption by the local farmers (Oliver and Dizon, 2016). Technical assistance, training, financial assistance, farmers' knowledge and monthly income were factors known to influence adoption of IPM. In particular, training remains as a top priority activity in various extension programs in the country (Oliver and Dizon, 2016). It is imperative that training designs suite the needs and conditions of stakeholders of IPM training programs. In fact, a number of growers still view IPM as an expensive and risky pest-management endeavor that many still choose not to practice (Farrar *et al.*, 2016). With sufficient information on participants' adoption, preferences and conversions to IPM, knowledge can be generated on how extension programs should be designed to meet the needs and match the conditions of the stakeholders.

Reports from various literature emphasized the limited and distant involvement of stakeholders in evaluating adoption of IPM (Parsa *et al.*, 2014). In fact, many literatures that exposed limited IPM adoption often originate from researchers situated in developed countries, many from western regions. With the limited amount of literature originating from developing countries, it is inevitable that policies developed in the national and local level in developing countries were highly influenced by these available literatures. However, diversity and marriage of knowledge among foreign and local literatures might provide a more insightful perspective on the issues related to IPM adoption and training needs of the local farmers in developing countries which imply that there is an urgent need to produce more substantial discussion on IPM adoption of developing countries.

Moreover, unlike in developed western countries, most farms in developing countries such as the Philippines are small and family-operated, many of which are less than two hectares. This huge discrepancy in farm size also contributes to a huge discrepancy in farm operations and IPM adoption, in particular (Lowder *et al.*, 2016). In addition to that, the type of crops planted, may it be annual or perennial, also contributes to this huge discrepancy. Management in annual crops considerably differ from that in perennial crops which mainly affects IPM adoption, although, concrete evidence is yet to be collected. Thus, it is vital to look at the perspective of both annual and perennial crop producers, and the type of IPM practices each grower type choose to adopt or preferred. Not only that, it also vital to determine the conversion from conventional practices to IPM-based practices, to assess the success of an extension program. Hence, this study aimed to examine the prevalence of IPM adoption by annual and perennial crop growers in Southern Philippines who were involved in a two-year IPM Training Program. Particularly, this study aimed to differentiate the level of adoption, IPM technology preferences and technology conversions among annual and perennial crop growers in Southern Philippines to deduce on the necessary information imperative in crafting extension training designs for sustainable extension programs.

## Materials and methods

### ***Description of the research area***

The study covered five towns in the Region of SOCCSKSARGEN (Region XII) which is located in Southern part of the Philippines. The total land area of the region is 2,243,651 hectares of which 775,309 hectares are mainly for agricultural production. The population of the region is more than 4 million in which about 837,000 people are involved in Agriculture (NEDA XII, 2011).

The five towns included in the study were General Santos City, Maitum in Sarangani Province, Surallah in South Cotabato Province, Bagumbayan in Sultan Kudarat Province and Midsayap in Cotabato Province. These towns were selected as recipients of a two-year IPM Program funded by the Commission on Higher Education - National Agriculture and Fisheries Education System of the Republic of the Philippines. The selection was done with assistance from the Department of Agriculture Region XII based on farmers' profile and the need for IPM trainings in the area.

From each town, at least one village were selected as study sites where data were collected from the training participants who also served as respondents of the study.

### *Selection of participants and training series*

There were 115 farmer participants in an IPM training program. There were 73 annual crop growers composed of 43 rice growers, 18 corn growers and 12 vegetable growers. Moreover, there were 42 perennial crop growers composed of 11 banana growers, 12 citrus growers, 13 coconut growers, one oil palm grower and five rubber tree growers. These farmers were selected with the assistance of the Department of Agriculture based on the following criteria: 1) They owned a minimum of half hectare of land; 2) They have not received any IPM training for the past ten years; and 3) They were willing to commit to the program.

Various training sessions were conducted in a span of two years from the year 2018 to 2019 which included lectures, hands-on, field trips, farm visits, demo farm activities and one-on-one teaching-assistance approach. Two training modules were developed and translated into four Philippine vernaculars, specifically, Bisaya, Hiligaynon, Maguindanaon and Filipino. These modules were used during the training sessions which covered 64 IPM Technologies including ETL-based pesticide use (Table 1).

### *Data collection and statistical analyses*

A one-on-one interview was conducted with each of the 115 farmer participants. This was done at the beginning and end of the training program.

The interview was guided by a questionnaire comprising of open and closed-ended questions. Specifically, the questions were related to the participants' technology adoption from among the 64 technologies taught during the program in relation to the crops that they were planting. The interview also included questions related to ETL and pesticide use. Data were collated and subjected to appropriate statistical analysis. Basic statistics such as frequency were obtained to compute for the percentages. A Pearson Chi-square Test of Independence was conducted to examine whether grower type, level of adoption, and technology adopted and preferred were independent. Fisher's Exact Test was used instead, when appropriate, when assumptions of the Chi-square Test were not met.

**Table 1.** Sixty-four technologies covered in the two-year IPM training program for annual and perennial crop growers of Southern Philippines

| IPM Pyramid Tier | IPM Technologies |
|---|---|
| Bottom (Abiotic actions) | *Pest Monitoring*: Average Pest Count, Pest and Disease Estimation, Viability Tests and Weed Control Action Indicator Determination; *Sanitation*: Burning, Pasturing, Proper Animal Waste Management, Proper Crop Harvest and Storage Management, Rouging, Cleaning, Shredding and Tillage; *Physical Control Practices*: Flooding, Girdling, Indigenous Mulching, Irrigation Control, Pest Disruption Methods, Reflective Mulches, Solarization, Sound, Insect Trap, Trap Barrier System and Trenching; *Plant-based Concoctions*: Calcium Phosphate (Cal Phos), Lactic Acid Bacteria Serum (LABS), Use of Fermented Fish Amino Acid (FFAA), Use of Fermented Fruit Juice (FFJ), Use of Fermented Plant Juice (FPJ), Use of Indigenous Microorganism (IMO), Use of Organic Pesticide and Use of Oriental Herbal Nutrients (OHN); *Composting*: IMO-based Composting, Natural Composting, Trichocomposting and Vermicomposting; *Farming System*: Farm Design, Organic Farming, Planting Date Manipulation, Planting Resistant Variety and Proper Crop Maintenance; *Conservation Practices*: Agroforestry Conservation, Border crop, Conservation Tillage, Contour Farming, Crop Rotation, Multicropping, Sloping Agricultural Land Technology and Terracing. |
| Middle (Ecology-based) | Predator; Parasitoid; Pathogen: *Metarhizium anisopliae* and *Trichoderma harzianum*; and Antagonist |
| Top | IPM-based Pesticide Use |

For the preferred technology, the percentage difference between adoption of annual and perennial crop growers was computed using the following formula:

$$\text{Percent Difference (\%Diff)} = 100 \text{ x } \frac{|A-B|}{\frac{(A+B)}{2}}$$

where: A, Percentage of adopters from annual crop growers
B, Percentage of adopters from perennial crop growers

For the technology conversion, the percentage conversion was computed using the following formula:

$$\text{Percent Conversion (\%Conv)} = \frac{E}{P} \times 100$$

where: E, Percentage of ETL-based pesticide users
P, Percentage of conventional pesticide users

Conventional pesticide users include individuals who apply pesticides as a main crop protection strategy. They were identified at the beginning of the training program. ETL-based pesticide users adopt application of pesticides based on IPM strategies and ETL. They were identified at the completion of the training program.

## Results

### *Level of IPM adoption by annual and perennial crop growers in Southern Philippines*

IPM adoption of annual crop growers ranged from 5.56% (Very high adoption) to 77.78% (Moderate adoption) while adoption of perennial crop growers ranged from 7.69% (Low adoption) to 76.92% (Moderate adoption) with no very high adoption (Table 2). Both annual and perennial crop growers mostly adopt IPM at moderate level and a few with low adoption. However, only annual crop growers showed very high IPM adoption.

A similar trend is evidently shown when categories were further divided into their component grower groups (Table 2). Growers of annual crops such as rice and corn adopted IPM with percentages ranging from 5.56% to 77.78% representing all adoption levels from low to very high adoption while growers of perennial crops such as banana, citrus, coconut and rubber adopted IPM with percentages ranging from 7.69% to 100.00% from low to high adoption levels but with no very high adoption. Growers of all crops in this study mostly adopt IPM at medium level except for rubber growers who only adopted at low level. Moreover, only rice and corn growers who were all annual crop growers adopted IPM at very high level.

The result of the Chi-square test was significant based on an alpha value of 0.10 and p value of 0.078, suggesting that Grower group and Level of adoption are related to one another. This signifies that there is an association between grower type and the level of IPM adoption. While 4.18% of annual growers adopt at very high level, none of the perennial growers adopt at this level. While 29.02% of perennial growers adopt at low level, only 17.81% of annual crop growers adopt at this level.

**Table 2.** Level of IPM adoption of annual and perennial crop growers of Southern Philippines (n, 115)

| Grower group | Percentage of adopters[1/] by level of adoption[2/] | | | |
|---|---|---|---|---|
| | Low | Moderate | High | Very High |
| Annual (n, 73) | 17.81 | 60.10 | 17.91 | 4.18 |
| Rice (n, 43) | 39.53 | 44.19 | 9.30 | 6.98 |
| Corn (n, 18) | 5.56 | 77.78 | 11.11 | 5.56 |
| Vegetables (n, 12) | 8.33 | 58.33 | 33.33 | 0.00 |
| Perennial (n, 42) | 29.02 | 53.29 | 17.68 | 0.00 |
| Banana (n,11) | 9.09 | 54.55 | 36.36 | 0.00 |
| Citrus (n, 12) | 8.33 | 75.00 | 16.67 | 0.00 |
| Coconut (n, 13) | 7.69 | 76.92 | 15.38 | 0.00 |
| Oil Palm (n, 1) | 100.00 | 0.00 | 0.00 | 0.00 |
| Rubber (n, 5) | 20.00 | 60.00 | 20.00 | 0.00 |

1/: **Significant using Pearson Chi-square Test based on an alpha value of 0.10 with p-value of 0.078. Percentage computed from frequency data and presented within grower group values. n, number of respondents.

2/: Level of adoption (based on the % of adopted technologies): Low (<25%); Moderate (25 to 50%); High (51 to 75%); and Very High (76% or higher).

***Preferred IPM technologies of annual and perennial crop growers in Southern Philippines***

Both annual and perennial crop growers similarly adopted at least one of the 64 technologies. IPM technologies related to Farming Systems such as Proper Crop Maintenance, Proper Crop Harvest and Storage Management and Planting Date Manipulation were adopted by most of the growers of over 80.00% with the adoption not significantly varying among grower groups.

The results of the Chi-square or Fisher's Exact Test (when appropriate) were significant based on an alpha value of 0.05 (Table 3). The p-values were 0.019 (Proper Harvest and Storage), 0.001 (Antagonism), 0.001 (IMO) and 0.028 (Agroforestry Management). The results signified that Grower group and Preferred IPM technology are related to one another, thus, there is an association between these variables. While a large percentage of perennial crop growers adopted proper harvest and storage ranging from 81.82% (Banana growers) to 100.00% (Growers of Citrus, Coconut, Oil Palm and Rubber), only 69.77% of rice growers adopted this practice.

**Table 3.** Preferred IPM technology adopted by annual and perennial crop growers of Southern Philippines (n, 115)

| **Grower group** | **Percentage of adopters[1/] by type of preferred IPM technology adopted[2/]** | | | |
|---|---|---|---|---|
| | **Harvest and storage** | **Antagonism** | **IMO[3/]** | **Agroforestry management** |
| Annual (n, 73) | 79.45 | 57.53 | 49.31 | 41.10 |
| Rice (n, 43) | 69.77 | 41.86 | 32.56 | 27.91 |
| Corn (n, 18) | 100.00 | 83.33 | 83.33 | 61.11 |
| Vegetables (n, 12) | 83.33 | 75.00 | 58.33 | 58.33 |
| Perennial (n, 42) | 92.86 | 80.95 | 80.95 | 57.14 |
| Banana (n,11) | 81.82 | 81.82 | 72.73 | 54.55 |
| Citrus (n, 12) | 100.00 | 75.00 | 83.33 | 50.00 |
| Coconut (n, 13) | 100.00 | 76.92 | 84.61 | 61.54 |
| Oil Palm (n, 1) | 0.00 | 100.00 | 100.00 | 0.00 |
| Rubber (n, 5) | 100.00 | 100.00 | 80.00 | 80.00 |
| Non-adopter[4/] | 18.00 | 39.00 | 45.00 | 61.00 |
| %Diff[5/] | 15.56 | 33.82 | 48.57 | 32.67 |
| *p-value* | 0.019** | 0.001** | 0.001** | 0.028** |

1/: **Significant using Pearson Chi-square or Fisher's Exact Test (when appropriate) based on an alpha value of 0.10 with p-value as shown in the table. Percentage computed from frequency data and compared among grower group values. n, number of respondents.
2/: Preferred IPM technology adopted was the technology with its adoption significantly higher to one grower group.
3/: IMO, Use of Indigenous Microorganisms
4/: Non-adopter, growers who did not adopt the IPM technology
5/: For the preferred technology, the percentage difference between adoption of annual and perennial crop growers was computed using the following formula: Percent Difference (%Diff) = $100 \times \frac{|A-B|}{\frac{(A+B)}{2}}$ ; where: A, Percentage of adopters from annual crop growers; and B, Percentage of adopters from perennial crop growers.

However, the percentage of adopters was also high for vegetable growers with 83.33% and 100%.00 for corn growers. Similarly, a large percentage of perennial crop growers also adopted antagonism ranging from 75.00% (Citrus) to 100.00% (Oil Palm and Rubber) with 76.92% for Coconut growers and 81.82% for Banana growers, between the ranges. Whereas, a lower percentage of adopters of antagonism (41.86%) was observed for rice growers, although percentages for vegetables (75.00%) and corn growers (83.33%) fall in the same range as perennial crop growers. Furthermore, a large percentage of perennial crop growers also adopted the use of the Indigenous Microorganisms (IMO) ranging from 72.73% (Banana) to 100.00% (Oil Palm) with 80.00% for Rubber growers, 83.33% for Citrus growers and 84.61% for Coconut growers, between the ranges. Similar to perennial crop growers, adopters of IMO use were also high for Corn growers with 83.33%, while Rice growers and vegetable growers were lower at percentages of 32.56% and 58.33%, respectively. Finally, Rubber growers had high adoption of Agroforestry Management at 80.00%. This was followed by Coconut growers with 61.54% adopters. Moreover, Corn growers followed next with slightly lower percentage of 61.11%. Vegetable growers (58.33%), Banana growers (54.55%) and Citrus

(50.00%) were lower but rice growers were still the lowest adopters with 27.91%.

***Conversion from conventional to ETL-based pesticide use of annual and perennial crop growers in Southern Philippines***

Majority of the respondents (>72%), who were identified as conventional pesticide users at the beginning of the program, converted as ETL-based pesticide users at the end of the program (Table 4). Most of the growers were conventional pesticide users at high percentage of 94.52% for annual crop growers and 88.01% for perennial crop growers.

**Table 4.** Conversion of adoption by annual and perennial crop growers in Southern Philippines from conventional pesticide use to ETL-based pesticide use (n, 115)

| Grower group | Percentage of adopters[1/] | | |
|---|---|---|---|
| | Conventional pesticide use | ETL-based pesticide use | %Conv[2/] |
| Annual (n, 73) | 94.52 | 79.45 | 84.06 |
| Rice (n, 43) | 100.00 | 76.74 | 76.74 |
| Corn (n, 18) | 77.78 | 88.89 | 114.28 |
| Vegetables (n, 12) | 100.00 | 75.00 | 75.00 |
| Perennial (n, 42) | 88.10 | 78.57 | 89.19 |
| Banana (n,11) | 100.00 | 72.73 | 72.73 |
| Citrus (n, 12) | 83.33 | 83.33 | 100.00 |
| Coconut (n, 13) | 84.62 | 84.61 | 99.99 |
| Oil Palm (n, 1) | 100.00 | 100.00 | 100.00 |
| Rubber (n, 5) | 80.00 | 60.00 | 75.00 |
| *p-value* | 0.047** | $0.853^{ns}$ | |

1/: **Significant using Pearson Chi-square based on an alpha value of 0.10 with p-value as shown in the table. ns, not significant. Percentage computed from frequency data and compared among grower group values. n, number of respondents.

2/: For the technology conversion, the percentage conversion was computed using the following formula: Percent Conversion (%Conv) = $\frac{E}{P}$ x 100, where: E, Percentage of ETL-based pesticide users, and P, Percentage of conventional pesticide users. Conventional pesticide users include individuals who apply pesticides as a main crop protection strategy. They were identified at the beginning of the training program. ETL-based pesticide users adopt application of pesticides based on IPM strategies and ETL. They were identified at the completion of the training program.

The results of the Chi-square Test were significant based on an alpha value of 0.05. The p-value was 0.047 indicating that Grower group and the practice of Conventional pesticide use were related to one another, thus, there is an association between these variables. Furthermore, no variability on adoption of ETL-based pesticide use was found based on the alpha value of 0.05 and p-value of 0.853. Adoption of ETL-based pesticide use was 79.49% and 78.57% by annual and perennial crop growers, respectively. Percent conversion (%Conv) from conventional to ETL-based pesticide use was lowest in banana growers (72.73%) and highest in corn growers (114.28%). Percent conversion for all crop growers was very high (>72.00%).

## Discussion

Adoption occurs when a new technology is applied in a long run resulting to equilibrium together with the farmer obtaining full information about this new technology and its potential (Kirinya *et al.*, 2013). Moreover, it also defined as the application of technology based on its recommended protocol with the farmer's willingness to accept this recommendation as a new part of his system (Kirinya *et al.*, 2013). In this study, adoption of both annual and perennial crop growers of IPM fall under low to moderate level adoptions. Moreover, only annual crop growers showed very high IPM adoption. Thus, Grower group and Level of Adoption are related to one another signifying that there is an association between grower group and the level of IPM adoption, as well as, Grower group and preferred IPM technology. Nevertheless, growers of all crops in this study mostly adopt IPM at moderate level except for rubber growers who only adopted at low level. Moreover, only rice and corn growers who were all annual crop growers adopted IPM at very high level. Prevalence of adoption between the two groups of growers does not differ significantly with exceptions of a few crops. This is similar to the results reported in literature in which no significant difference in IPM adoption among different farmer groups (either district wise or cultivation region wise) was observed (Jayasooriya and Aheeyar, 2016). Disseminating fairly simple technologies than the complex ones with high risks allow better IPM adoption (Lukuyu *et al.*, 2012) such that what was provided in this study during training sessions. Since adoption is a process, adoption by the farmers at the levels mentioned earlier is a good sign for the eventual increase in IPM practice among both annual and perennial crop growers. Moderate level adoption is the requisite to finally obtaining high to very high adoption with time. This is possible with the continuous assistance from the local and national agricultural agencies and extension workers who will be filling knowledge gaps in IPM adoption.

Moreover, Grower group and Level of Adoption are related to one another signifying that there is an association between grower group and the level of IPM adoption. Adoption significantly different across farmer groups but this true only for the four technologies of the 62 technologies introduced. However, the pattern of adoption was similar based on the least-adopted and most-adopted technologies. This observation is similar to what was reported in the literature indicating that technology adoption pattern is consistent across farmer groups (Barrera *et al.*, 2005). Practices under Farming Systems such as Proper Crop Maintenance, Proper Crop Harvest and Storage Management and Planting Date Manipulation were adopted by most of the growers of over 80.00% with the adoption not varying between grower types except for proper crop harvest and storage. As always, emphasis lies on the fact that more complex practices which are perceived to be most risky and capital-intensive are least adopted than the simple ones (Barrera *et al.*, 2005). Furthermore, simple practices have lower risk, with low to moderate complexity, and not capital-intensive, thus, generate better adoption even if many of these technologies require additional labor (Barrera *et al.*, 2005). This signifies that labor intensity is not a major problem for farmers to adopt IPM technology (Barrera *et al.*, 2005). Furthermore, the goal of IPM adoption has always been related to productivity impact in which farmers who adopted IPM practice expect to observe statistically similar productivity in terms of yield per hectare (Rahman and Norton, 2019). Nevertheless, specific strategic goals must be met for better outcomes (Mazur, 2014).

Most of the growers were conventional pesticide users at a high percentage at the beginning of the training program. Their adoption of ETL-based pesticide use did not differ with the grower group regardless of the crop that they grow. This behavior of the farmers on pesticide use is always driven by economics, thus if IPM adoption becomes lagging, relatively simple solutions must be provided (Alwang *et al.*, 2019). It is fortunate to know that a high percentage of farmers in this study knew ETL-based pesticide use since knowledge is essential for farmers to be more cautious in handling pesticides (Barrera *et al.*, 2005). In fact, pesticide use declines drastically through time when farmers become more aware of the impacts to human health and environment that these chemicals are causing (Farrar *et al.*, 2016). Therefore, training emphasis, whether farmers grow annual or perennial crops, must be on the design of the technology package, not only leading to economic benefit but also reduction of environmental pollution (Kirinya *et al.*, 2013).

Hence, this study presented that IPM adoption is prevalent in annual and perennial crop growers in Southern Philippines. Particularly, there are a number of differences in terms of the level of adoption and preferred IPM technologies adopted by annual and perennial crop growers. Since IPM adoption trend showed a promising trend for both annual and perennial crop growers, IPM managers and extension workers must continue to develop effective pest-management tools and techniques that are simple and valuable while protecting human health and the environment. Filling the knowledge gap of the farming community and its extension services in IPM by designing tailor-made, simplified and farmer-centered IPM training packages and programs can lead to better community awareness and IPM adoption.

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