Perceived Impacts of Current Pest Management Strategies on Fruit-Bearing "Carabao" Mangoes in Negros Oriental, Philippines

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The Philippine mango industry is a significant contributor to the country's agricultural export earnings. However, this sector's continued viability remains to be threatened by a variety of pests that affect yield performance and quality of produce. The study examined the pest management strategies employed in mango farms in Negros Oriental, Philippines, and their impact on pest reduction, yield, profitability, and the environment. In-depth interviews were conducted with 100 randomly selected owners of "Carabao" mango trees and 100 sprayer-contractors in selected southern and northern municipalities in the province. Results show that the surveyed farmers had an average of 33 fruit-bearing Carabao mango trees, all artificially induced to flower. Except for six farmer respondents, the rest hired sprayer-contractors to perform floral induction and manage the entire fruit development stages. Respondents reported that in the absence of reliable alternatives, pesticides constitute the core pest management strategy. In all farms, insecticides were applied on scheduled timings at least six times between bud emergence to fruit maturity, while 54% of the surveyed farms utilized fungicides. Respondents indicated that pesticide application reduced pest damage by more than 50%, significantly increased harvestable yield, and made mango production profitable. However, respondents averred that excessive pesticide use is potentially hazardous to human health and contaminates the air, water, and soil resources.

Keywords: Pests, Pest Management, Pesticide Use, Pollution

INTRODUCTION

The production and export of fresh fruits play an essential role in the Philippine economy. Mangoes rank third among the most important fruit crops in the Philippines, after bananas and pineapples regarding area and volume of production (PSA, 2019). In 2018, fresh mango exports were valued at Php 990.2 million, while processed mango export products such as dried fruits, mango puree, and others were valued at more than Php 3.2 billion. The estimated value of the mango industry's production was about Php 27 billion, constituting about 1.57% of the gross output of agriculture in 2018 (PSA, 2019). In the same year, the Philippines ranked 12th as the world's largest mango producing country.

In 2013, there were 1,963,254 mango farms in the country, with a total area of 187,838 hectares producing 816,199 metric tons of fruits. Close to 73% of the area planted with mangoes in the country is owned by smallholder farmers. The Philippine mango industry supports as many as 2.5 million Filipinos.

However, mango production in the country continues to be plagued by high pest and disease incidence resulting in production decline and poor quality of fruits (PCARRD, 2006). Indeed, crop pests and diseases can cause severe damage, which leads to significant reductions in farm yields and incomes, despite the existence of alternative strategies to pest management. Kesavachandran et al. (2006) reported that pesticides are still aggressively promoted to increase agricultural productivity and eliminate pests and vector-borne diseases in many parts of the world.

To minimize economic losses due to various types of pests, farmers commonly resort to pesticides (Raju et al., 2011). The latter is a class of chemical substances placed directly to the soil or sprayed on crops to control destructive organisms such as insects, fungi, molds, nematodes, and rodents (Rodriquez et al., 2011). According to Mariyono and Battharai (2009), the principal rationality for employing pesticides in farms is the economic motive of reducing yield loss, thereby improving productivity and income. They explained that farmers' decision to apply pesticides on a crop is a preventive mechanism against crop failure due to pests and disease attacks. As propounded, elimination of pesticide use in intensive farming can substantially reduce crop yield, and in extreme cases, lead to zero levels of production (Knutson

& Smith, 1999). The loss could vary by location, nature of farming, history of pest infestation, and many other factors (Mariyono & Battharai, 2009).

Pesticides are known for their resilience against chemical and biological degradation, high environmental mobility, bioaccumulation in human and animal tissues, and impacts on human health and the environment, even when used in deficient concentrations (Liu et al., 2009). In many instances, the use of pesticides has caused adverse effects on human health (Lu, 2009; Raju et al., 2011), particularly among those exposed to it during the application period or those that consume agricultural products contaminated with their residues (DPR, 2008). Furthermore, there are other equally alarming negative externalities resulting from the misuse of pesticides, such as "environmental damage to the soil, surface water, groundwater, and air quality" (Lu, 2010). Pesticides reportedly contaminated land and water in areas sprayed aerially or allowed to run off fields (Damalas et al., 2011). A US Geological Survey showed that the United States' pesticides had polluted every stream and more than 90% of sampled wells (Gilliom et al., 2007).

Today, several destructive pests and diseases beset the Philippine mango industry. In response to this, farmers resorted to applying a wide range of broad-spectrum pesticides as a principal means of control against these pests and diseases (Bodnaruk, 2008). Locally, there are no known studies that focus on assessing the impacts of current pest management strategies in mango plantations in the province of Negros Oriental. Hence, this study sought to determine the effects of pesticide use in mango farms in the area on pest reduction, yield, profitability, and the environment. The study intends to help government officials craft local policies on improving mango productivity while sustaining the environment through safe agricultural management practices shall be the focus of this study.

METHODOLOGY

The study is descriptive. It utilized surveys and observational methods for data collection. Purposive quota sampling was employed to obtain 100 mango farmers and 100 sprayer-contractors as respondents for this study. For inclusion in the study, the mango farmers must have at least five (5) Carabao mango trees bearing fruits for at least five (5) years in any northern or southern municipality in the province of Negros Oriental. On the other hand, the sprayer-contractors must be either contractors, hired sprayers, or sprayer-contractors actively engaged in mango spraying operations in the province for at least two years at the time of the survey.

The mango farmers and sprayer-contractors randomly selected for this study came from nine municipalities; four (4) represented the northern municipalities such as Ayungon, Bindoy, Manjuyod, and Amlan. The municipality of Ayungon is within the geographic confines of 9° 52' 32" N latitude and 123° 9' 40" East longitude, and the municipality of Bindoy at latitude 9°45'38", N longitude 123 ° 8'33" E with a distance of 8.5 kilometers south of the City of Dumaguete. Meanwhile, the municipality of Manjuyod is within the geographic confines of 9°41'46" N latitude and 123 ° 9'43" E longitude, and the municipality of Amlan at 9° 26' 39.71" N latitude and 123°10'48.47" E latitude.

The municipalities of Bacong, Valencia, Dauin, Zamboanguita, and the city of Dumaguete represented the southern side of the province. Located at latitude 9°14'50.2" N longitude 123 ° 17'37.3" E with a distance of 8.5 kilometers south of the City of Dumaguete is Bacong. Valencia is within the geographic confines of 9° 16' 00" to 9° 20' 00" N latitude and 123°04'00" to 123°12'00" E latitude. The municipality of Dauin is at latitude 9°11'28" N longitude 123 ° 15'56" E of Dumaguete City and the municipality of Zamboanguita at 123 ° 8'47.04" E longitude and 19 ° 10'12.42" N latitude. Dumaguete City lies within the geographic confines of 9° 18' 24.62" N latitude and 123°18'19.62" E latitude.

Primary and secondary data collection methods were employed to obtain data for this study. Primary data came from mango farmers and mango sprayer-contractors interviewed using structured personal interviews by trained enumerators.

Details on pest management practices among key informants using informal interviews and observation methods on selected mango farms and sprayer-contractors for needed information on pesticide application practices constituted the primary data source for this study. Official statistics and internet databases of pertinent data and information represented the secondary data for the study.

Data were analyzed using the SPSS program. Descriptive statistics was employed to describe and summarize the data collected.

RESULTS

The study focused on farmers and sprayer-contractors of “Carabao” mango, considered the most economically important mango cultivar grown in the country, having been tagged by the Department of Science and Technology (DOST) an export winner. It is also known as “Manila Super” in the world market. It is a highly seasonal fruit with its natural fruiting season mostly occurring in April and May. However, with floral inducers, it is now possible for “Carabao” mango trees to flower and produce all year round (PCARRD, 2006).

Socio-demographic Characteristics of Respondents

Table 1 presents some of the socio-demographic attributes of the study respondents. Most of the surveyed mango farmers and sprayer contractors were males. The latter was younger by about ten years with a mean age of 35.56 years old, compared to the farmers’ mean age of 45.46 years. Farmers were mostly (82%) married with more children, but 45 % of the sprayer-contractors were single. For both categories of respondents, household size was practically the same at about five members. The majority of the sprayer-contractors have completed at least elementary education, while more than one third (36%) of the responding mango farmers have either earned or completed some college education.

Table 1
Selected Demographic Characteristics of Mango Farmers and Sprayer-Contractors in Negros Oriental, Philippines

Characteristics	Farmers N=100	Sprayer-Contractors N=100
Gender		
Male	71	99
Female	29	1
Mean Age (Years)	45.46	35.56
Civil Status		
Married	82	55
Single	18	45
Mean Number of Children	2.82	1.41
Mean Household size	4.92	5.01

Educational Attainment		
No Formal Education	2	-
Elementary Level/Graduate	38	53
High School Level/ Graduate	24	38
College Level/Graduate	36	8
Master's Degree	-	1

Farming-Related Factors

The majority (75%) of the farmer respondents owned farmlands with portions planted to mango trees, while 15% were tenants or caretakers (Table 2). The farm's size averaged 2.52 hectares, with mango trees planted in about half (1.2 hectares) of the land. On the other hand, only six (6) of the sprayer-contractors owned farmlands, which averaged 3.3 hectares, about three-fourths of which (2.4 hectares) were devoted to mango production.

The number of mango trees per farmer widely varied with a range of five to 500 trees. On average, the surveyed farmers had 37.2 trees, most (89%) at the fruit-bearing stage. On the other hand, the six sprayer-contractors had mango trees numbering 12 to 460 trees, with a mean of 138 trees, all of which were at the fruit-bearing stage. The surveyed mango farms were mainly small scale.

The surveyed mango farmers and sprayer-contractors varied in their length of engagement in mango farming-related activities. On average, the mango farmers had relatively long experience in mango farming with a mean of 14.13 years, compared to the sprayer-contractors' average of 12.5 years of experience in mango spraying operations (Table 2).

All of the surveyed mango farmers with bearing trees had their trees artificially induced to flower to ensure greater regularity in fruiting. However, only six (6) of these farmers did the floral induction of their trees by themselves, with most (94%) opting to contract mango sprayer-contractors' services on an output-sharing scheme. The latter set-up implies that sprayer contractors assumed full responsibility for all decisions about floral induction, including pest management decisions.

The majority (56%) of the surveyed mango farmers enumerated why they opted to hire sprayer-contractors to induce and manage their bearing mango trees. Topmost in the list is lack of training, knowledge, practical skills on the procedures and requirements of floral induction; lack of capital for the required spraying equipment, transportation, chemicals, and labor costs; and lesser risk on the part of the owner in the event of an unsuccessful operation thereby avoiding possible losses.

The mango spraying operations of the surveyed sprayer-contractors are quite extensive and widespread. The number of mango farms sprayed ranged from one (1) to 300 farms, with an average of 19.93 farms located in different parts of the province and in nearby areas. The number of mango trees sprayed by the contractors ranged from five to 5000 trees in a year, with an average of about 611 mango trees annually.

Table 2
The Average Size of the Whole Farm and Mango Farm, Number of Mango Trees, the Number of Farms, and Mango Trees Sprayed per Year

Charateristics	Mango Farmers N=100	Sprayers N=6
Mean Total of Cultivated Land for All Crops (has.)	2.525	3.33
Mean Total Cultivated Land for Mangoes (has.)	1.329	2.400
Mean Total Number of Mango Tree	37.2	138.67
Mean Total Number of Bearing Trees	33.08	138.67
Mean Total Mango Farming Experience	14.13	12.51
Mean Number of Mango Farms Sprayed/Year		19.93
Mean Number of Mango Trees Sprayer/Year		611.53

Pest and Disease Incidence

Carabao mango trees are susceptible to some pests and diseases, particularly at the flowering and fruit development stages. Table 3 presents the different stages of flower and fruit development of mango and the major insect pests and diseases experienced by the surveyed mango farmers and sprayer-contractors at each stage. As reported, "flower worms or caterpillars" (Family *Pyralidae, Geometridae, Noctuidae*) and hoppers (*Idioscopus clypealis Leth*) are two insect pests that are destructive during the flowering stages of mango from bud emergence to full bloom by attacking the developing inflorescence. Reportedly, hoppers continue to be destructive until fruit is set. Four insect pests such as hoppers, fruit flies (*Bactrocera philippinensis Bezzi*), cecid flies (Procantarinia mangifera), and black ants (*Monomorium minimum)* were reportedly present and harmful during the fruit development stages of the surveyed farms from fruit set until fruit maturity. The nocturnal cecid flies usually occur as early as the fruit setting stage until the fruit development stage (61-89 DAFI). Fruitflies are widely considered as the most severe pest from fruit development to fruit maturity.

Among the pests, hoppers were cited by most to have the highest incidence and caused the most severe damage and highest yield loss regardless of the season. **The majority cited no other insect pest to be highly destructive, although fruit flies and cecid fly were generally damaging.**

Furthermore, three economically essential diseases infected many of the surveyed mango farms at different growth stages. Anthracnose threatened mango production throughout the flowering and fruit development stages. On the other hand, sooty mold, often associated with mango hoppers, infected mango trees during the flowering stage, while scab occurred at the fruit development stages.

Table 3

Insect Pests and Diseases Observed by Sprayer-Contractors and Farmers to be Destructive at Different Flowering and Fruit Development Stages of Induced "Carabao" Mango Trees

PESTS	**Flowering and Fruit Development Stages**							
Insects	**Bud Emergence** (10-14 DAFI)	**Bud Elongation** (15-21 DAFI)	**Early Opening Prebloom** (22-26 DAFI)	**Full Bloom** (27-33 DAFI)	**Fruit Setting Mungbean Size** (34-46 DAFI)	**Fruit Setting** (Corn Seed to Egg Size) (47-60 DAFI)	**Fruit Deve-lopment** (61-89 DAFI)	**Fruit Matu-rity** (90-120 DAFI)
Hoppers	→	→	→	→	→			
Caterpillars	→	→	→	→				
Cecid Flies					→	→	→	
Fruit Borers						→	→	→
Fruitflies						→	→	→
Mealy Bugs						→	→	→
Black Ants						→	→	→
Diseases								
Anthracnose	→	→	→	→	→	→	→	→
Scab					→	→	→	
Sooty Molds	→	→	→	→	→			

Pest Management Strategies

The survey has shown that both cultural and chemical-based methods of pest control were employed in the covered mango farms to deal with insect pest infestation and disease infection during the flowering and fruit development stages.

Cultural Methods of Pest Control

Data in Table 4 show the specific cultural practices reported by mango farmers and sprayer-contractors done in the mango farms they owned or serviced-sprayed, respectively. A thorough examination of the data reveals that except for fruit bagging, the two groups of respondents have adopted an insufficient number of cultural management strategies. Fruit bagging is pervasive in Carabao mango farms to protect developing fruits mainly from the attacks of fruit flies and, to some extent, scale insects, mealybugs, and other insect pests. Rectangular paper bags made of old newspapers wrapped the fruits at 55 to 60 days after floral induction.

The majority (76%) of the surveyed farmers reported that they practiced "smoking" of their trees by burning plant debris, coconut husks, and other materials, including rubber in a few farms, to drive away insect pests. It appears that this was a practice that they performed before the sprayer-contractors took control of the management of flowering and fruiting stages of the trees since only two (2) sprayer-contractors claimed to have done this in the mango trees they managed. The negligible number of sprayer-contractors doing this practice suggests that this is not part of the usual regime since it is laborious and entails an ample supply of materials that may not be readily available.

While recommended as a pest management strategy, pruning of dead, infected twigs and branches to remove or minimize sources of inoculum of infestation (PCARRD, 2006) was an uncommon practice with only 23% and 46% of mango farmers and sprayer-contractors, respectively, claiming to have performed it regularly. The higher percentage of sprayers than farmers practicing pruning suggests that the former may have assumed such critical decisions, especially since they practically control all field operations, particularly about the floral induction and subsequent actions. Sanitation practices, including removing and disposing of infected or infested fruits, leaves, and other plant debris on the ground, were conducted by more sprayer-contractors (34%) than farmers (6%).

Table 4
Cultural Pest Management Methods Reported by Surveyed Respondents

Cultural Methods of Pest Management	Farmers N=100	Sprayer- Contractors N=100
	Percent Reporting	
Fruit Bagging	100.00	100.00
Smoking	76.00	2.00
Pruning	23.00	46.00
Sanitation	6.00	34.00

Chemical Control Methods

In the surveyed mango farms, the pesticides as a primary pest management strategy have become an integral practice. Pesticides, mainly insecticides, and fungicides were used extensively in mango farms covered in the study by the sprayer-contractors and mango farmers. Regardless of the season, all of the surveyed sprayer-contractors applied insecticides as a principal insect pest management strategy. Fungicides were also used by 54% of the sprayers during the wet season and 51% during the dry season.

Profile of Pesticides Used

The insecticides applied to bear mango trees belonged to eight (8) subgroups or chemical families, with a combined total of 13 different active ingredients, contained in 15 different chemical trade names. Figure 1 shows the distribution of sprayer-contractors by a subgroup of chemicals used. The top five chemical families regarding the percentage of respondents using them were Organochlorine (87%), Thiocarbamate (50%), Pyrethroids (46%), Carbamate (45%), and Thiadizin (20%). Chemicals least used were Organophosphates + Carbamate (7%), organophosphates (4%), and Pyrethroids + Neonicotin (4%). Among these groups, Pyrethroids had the most active ingredients consisting of Beta-Cypermethrin, Beta-Cyfluthrin, Cypermethrin, Fenvalerate, and Lambdacyhalothrin. The data indicate that mango sprayers did not use only one but multiple subgroups of insecticides during the flowering and fruiting stages of induced mango trees.

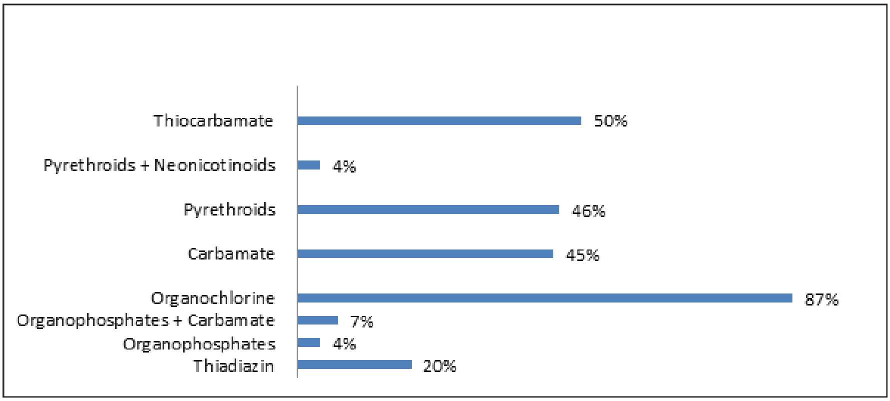

Figure 1. Subgroups/chemical families of insecticides applied on induced mango trees and the percentage of sprayer-contractors using them

The Frequency of Pesticide Application

Table 5 presents data on the frequency of pesticide application on flowering and fruit-bearing trees during the wet and dry seasons. Note that only six (6) of the mango farmers managed their trees' fruiting stages of their trees, while 94 hired sprayer-contractors. Data show that the application of insecticides ranged at varying frequencies from four to seven applications. However, the average number of pesticide applications during the wet and dry seasons was practically the same at 6.42 and 6.43 applications, respectively. The majority (57%) of the sprayer-contractors applied insecticides florally seven times, regardless of the season.

On the other hand, fungicides on mango trees were not as pervasive irrespective of the season. During the wet season, only 54% of the sprayer-contractors applied fungicides, declining to 51% during the dry season. Fungicide application during rainy and dry seasons ranged from 0 to 7, with an average of 1.39 applications during the wet season and 1.3 applications during the dry season. The difference in the percentage of fungicide users is attributed to the higher incidence of fungus-related infections during the wet season. The data suggest that a more significant number of respondents regarded fungicide use to be more indispensable during the wet season than the dry season, where the incidence of scab, in particular, is widely observed to be higher.

Table 5

Number of Pesticide Applications per Flowering-Fruiting Season during Wet and Dry Seasons by Farmers and Sprayer- Contractors

Frequency of Pesticide Application	Wet Season		Dry Season	
	Farmers N=6	Sprayer-Contractors N=100	Farmers N=6	Sprayer-Contractors N=100
Insecticides	**Percent Reporting**			
1-2	-	-	-	-
3-4	-	4	-	3
5-6	6	39	6 (100)	40
Above 6	-	57	-	57
Mean	5.83	6.42	5.83	6.43
Range	5-6	4-7	5-6	4-7
Standard Deviation	0.41	0.79	0.41	0.79
Fungicides	N=6	N=54	N=6	(N=51)
1-2	2	31 (57.41)	4	28 (54.90)
3-4	2	19 (35.19)	1	19 (37.25)
5-6	2	1(1.79)	1	1 (1.96)
Above 6	-	3 (5.36))	-	3 (5.88)
Mean	1.57	1.39	1.29	1.30
Range	0-6	0-7	0-6	0-7
Standard Deviation	2.30	1.63	2.36	1.63

Effect of Pesticide Use on Pest Damage Reduction, Yield, and Profit

Drawing from their experience in mango production, the respondents assessed the effects of pesticide use in reducing pest damage, yield, and profitability. Table 6 shows the mango farmers' and sprayer-contractors' perceived impacts of insecticide and fungicide application on fruit-bearing mango trees on insect pest reduction, level of fruit yield, and profitability during the wet and dry seasons.

Reduction of Pest Damage

Insecticides are widely perceived to be generally useful in reducing pest damage in mango farms by farmers and sprayer-contractors. Most (96%) of the sprayer-contractors indicated that insecticide application reduced pest damage by at least 51%, to as high as 75% regardless of the season. The rest reported a 26 to 50% reduction in pest damage. On the other hand, although only six (6) of the farmers did the actual spraying of their mango trees and the rest relied on sprayer-contractors' services, the majority pointed out that insecticide application reduced pest damage by 50 to 75% during the wet season and dry seasons.

On the other hand, respondents who applied fungicides on their mango trees reported its positive effect in reducing fungus-related damage, with most estimating more than 50% reduction in damage in both the dry and wet seasons. Although most farmers were not directly involved in spraying operations, the majority thought that fungicides could effectively reduce fungal damage by at least 50%.

Yield/ Productivity

The effect of pesticide use on mango yield was ascertained by asking mango farmers and sprayer- contractors whether such chemicals helped improve mango harvest based on the most recent cropping seasons. Data show that farmers who sprayed their mango trees by themselves and sprayer-contractors shared similar perceptions of insecticide application's contribution to increasing harvestable yield with all of the farmers indicating increased yield for both wet and dry seasons. On the other hand, the percentage of sprayer-contractors reporting increased yield resulting from pesticide application was higher for the dry season (71%) than 66% for the wet season.

Profitability

As expected, the surveyed farmers and sprayer-contractors who cited an increase in harvestable yield resulting from pesticide use also reported that pesticide use is profitable. There was an increase in yield regardless of the season. Although pesticides were not considered cheap, the value of their effect on pest damage reduction and consequent increase in harvestable yield was higher than the additional costs incurred by their use. Additionally, the use of pesticides was widely perceived to improve their product's physical appearance of their product, which favorably affects its market price.

Table 6
Perceptions of the Effectiveness of Insecticides and Fungicides during the Wet and Dry Season

Particulars	Insecticide				Fungicide			
	Wet Season		Dry Season		Wet Season		Dry Season	
	Farmers N=6*	Sprayers N=100	Farmers N=6	Sprayers N=100	Farmers (N=6)	Sprayers (N=54)	Farmers N=6	Sprayers N=51
Reducing Pest Damage	Percent Reporting							
<25%	-	-	-	-	-	-	1.00	-
25-50%	-	4.00	-	4.00	-	-	-	2 (3.92)
50-75%	4.00	58.00	5.00	54.00	3.00	25 (49.02)	3.00	24(47.05)
>75%	2.00	38.00	1.00	42.00	2.00	26 (50.98)	1.00	25 (49.02)
No Answer	-	-	-	-	1.00	-	1.00	-
Yield								
Increased	6.00	66.00	6.00	71.00	5.00	44 (86.27)	4.00	45 (88.23)
Unchanged	-	21.00	-	15.00	-	4 (7.84)	-	3 (5.88)
Reduce Yield	-	1.00	-	2.00	-	1 (1.96)	-	-
Not Sure	-	12.00	-	12.00	1.00	2 (3.92)	2.00	2 (3.92)
No Answer	-	-	-	-				1 (1.96)
Profitability								
Profitable	6.00	79.00	6.00	93.00	5.00	48 (94.12)	4.00	50 (98.03)
Break-Even	-	15.00	-	2.00	-	1(1.96)	-	-
Loss	-	2.00	-	-	-	1 (1.96)	-	-
Not Sure	-	5.00	-	5.00	1.00	1 (1.96)	2.00	1 (1.96)

*Only six of the 100 surveyed mango farmers induced their mango trees by themselves and managed the fruiting stages.

Perceived Adverse Effects of Pesticide

While most of the surveyed farmers had a favorable view of the effects of pesticide use on reducing crop pest damage and improving yield and profitability of mangoes, they were also aware of the potential adverse impact of pesticide use. The perceived negative impacts of pesticide use revolved around its possible effect on human health and the environment (Table 7).

Ranked first among the perceived adverse effects of pesticide use in mango farms is its potentially harmful and detrimental effects on human health, mainly to farm labor who are most directly and frequently exposed to it, as cited by the majority (75%) of the sprayer-contractors. The majority of the respondents recognized that the adverse health effects of pesticide use in farms are not only limited to those who applied them. People who work or live close to farms that heavily use pesticides may inhale pesticide aerosols or mists from nearby farms, as was supported by 72% of the respondents who cited air pollution as an adverse effect. Furthermore, 70% of the respondents cited "contamination of fruits or produce" with pesticide residues as another harmful effect of pesticide use.

Pesticides were also perceived to have adverse environmental effects such as water pollution (48%) and soil contamination (27%). There appears to be very little recognition among the sample farmers (14%) of pesticides' potentially harmful effects on the pests' natural enemies that could also be present in their farms.

Table 7
Adverse Effects of Pesticide Use on Farms as Perceived by Sprayer-Contractors

Adverse Effects	Percent Reporting	Rank
Harmful effects on human health	75	1
Air pollution	72	2
Contamination of fruits or produce with pesticide residues	70	3
Water pollution	48	4
Soil contamination	27	5
Destroys beneficial organisms	14	6

DISCUSSION

Effects of Pesticide Use

Insecticides were widely perceived to be generally useful in reducing pest damage in mango farms by farmers and sprayer-contractors. This finding is significant, considering that according to Banjo et al. (2010), losses due to pests and weeds could range from 10-90% for all potential food and fiber products. In mango production, major insect pests such as hoppers, fruit flies, and capsid bugs reportedly caused significant yield losses by as much as

90% if left uncontrolled (Chin, 2010). Hence, a reduction in damage and crop losses by more than 50% due to pesticide application, as was reported by the majority of the surveyed farmers, is economically advantageous to farmers. According to Hussain et al. (2002), pesticides are used on a massive scale on mango plantations to avert economic losses caused by these harmful insects, fungi, weeds, and others. According to Fabro and Varca (2012), pesticides benefit Filipino farmers by decreasing crop losses due to various insect pests, weeds, plant diseases, rodents, and other problems.

Generally, farmers and sprayer-contractors reported that insecticides on bearing mango trees have contributed to increasing harvestable yield for both wet and dry seasons. As more sprayer-contractors reported a significant reduction in insect pest damage due to pesticide application, correspondingly, a higher percentage also reported increased yield. An increase in yield is possible since the use of insecticides on bearing mango trees has reportedly brought down the level of pest damage by at least 50 % to as high as 75%. For instance, farmers contend that without pesticide application, the bearing mango trees, which were severely infested by some insect pests, mainly hoppers or fruit flies, could have been severely damaged, thereby adversely affecting yield. As a result of this observation, farmers employed the use of pesticides for pest control. Hence, they reported a reduction in pest damage and consequent improvement in the harvestable yield.

Similarly, the application of fungicides reportedly contributed to increased yield. These findings drew support from the findings of Jeyanthi and Kombairaju (2005). They pointed out that the intensive use of pesticides had significantly increased farmers'productivity in some parts of India. For this reason, Birthal et al. (2000) declared that pesticides had helped Indian farmers to achieve a substantial increase in agricultural productivity. However, the on-farm benefits of pesticides were offset to some degree by the off-farm costs imposed by them on the environment (Jeyanthi & Kombairaju, 2005).

While most of the surveyed farmers had a favorable view of the effects of pesticide use on reducing crop pest damage and improving yield and profitability of mango farms, they were also mindful of the potential adverse impacts of pesticide use. Ranked first among the perceived adverse effects of pesticide use in mango farms is its potentially harmful and detrimental effects on human health, mainly to farm labor working in direct contact and frequently exposed to the chemicals. The respondents also recognized that the adverse health effects of pesticide use in farms are not only limited to those who applied them. Meanwhile, indirect exposure occurs among people who live close to farms, which heavily use pesticides or buy fruits coming from such farms using pesticides. The former may inhale pesticide aerosols or mists from nearby farms or consume vegetables that contain pesticide residue levels exceeding the Maximum Residue Level (MRL). Among the reported health problems experienced by farmers that handle the chemicals are a pain in the abdomen, dizziness, headache, nausea, vomiting as well as skin and eye problems (Ecobichon, 1996; Banjo et al., 2010).

Based on their study, Hussain et al. (2002) reported that various insecticides and fungicides had been used on mangoes on a massive scale to minimize economic losses caused by insect pests and fungi. However, they averred that when misapplied, pesticide residues can remain on foods and, as such, can pose a significant hazard to human health. The perceived negative impacts of pesticide use revolved around its potential effect on human health and the environment. As Fabro and Varca (2012) pointed out, pesticides are poisons that, if improperly used or used with very little knowledge of their side effects, can endanger humans and animals due to the accumulation of persistent pesticide residues within the food chain and the contamination of the environment.

The use of pesticides was also widely perceived to have adverse environmental effects such as air pollution and soil contamination and is consistent with the report on the organophosphorus application to control agricultural pests. Issues associated with this today led to soil contamination either by a direct application or spray drift (Cycon et al., 2013), as was shown by Fosu-Mensah et al. (2016).

However, there appears to be very little recognition among the sample farmers of their potentially harmful effects on the pests' natural enemies that could also be present in their farms. The majority were not particularly wary that pesticide use does not only eliminate or control targeted pests but also other beneficial organisms present in their farms (Ecobichon, 1996). Banjo et al. (2010) stressed that many of the herbicides, and insecticides, act on a comprehensive spectrum of target species, which hurts the food chain of the wildlife inhabitants resulting in an indirect impact on species that eat specific prey or use the affected habitats. Also, Ecobichon (1996) and Banjo et al. (2010) pointed out that the constant use of pesticides led to secondary pest outbreaks and the widespread resistance development. This phenomenon results in the insecticide's inability to kill its target organisms at the prescribed dosage formally found to be lethal (Georghiou & Melon, 1993; Banjo et al., 2010).

CONCLUSION

The surveyed "Carabao" mango farms were generally small scale and were all artificially induced to flower to ensure regularity in fruiting. Hired sprayer-contractors managed the flowering and fruiting stages of most mango farms. Hence, pest management decisions, particularly about pesticide use, were wholly vested in the sprayer-contractors. Farm owners have voluntarily relinquished control of their mango farms to sprayer-contractors due to lack of knowledge and practical skills, lack of capital, and aversion to production and financial risks.

The surveyed mango farms were vulnerable and susceptible to a wide range of destructive insect pests and diseases, particularly at the flower and fruit development stages. Pesticide application is the core pest management strategy in all of the surveyed farms and by all sprayer-contractors. It is a pervasive and profoundly entrenched practice spawned by farmers' aversion to production risks brought about by the destructive effects of pests on yield and profit.

The application of pesticides on bearing mango trees has reportedly brought positive impacts regarding reduced crop pest damage, increased yield, and enhanced profitability of mango farms. However, excessive and persistent use of the chemical on farms was widely perceived as hazardous to human health and caused adverse environmental effects regarding air, water, and soil pollution.

RECOMMENDATIONS

So that proper management of pesticide use is enforced, the Local Government Units in the province must adopt local policies to regulate the sale and use of pesticides in farms. The provision for incentives to farmers practicing reduced pesticide usage and set-up mechanisms for regular monitoring of the level of pesticide contamination on harvested mango fruits, farm soils, and groundwater resources in tandem with the BPI Pesticide Analytical Laboratory Regional Office or the Fertilizers and

Pesticides Administration. Good agricultural practices must be enforced. Furthermore, local agricultural extension programs of the Department of Agriculture should emphasize the use of good agricultural practices (GAP) to ensure high farm productivity without compromising food safety and environmental integrity.

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