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Farmers' Assessment of Impacts of Philippine Warty Pig (*Sus philippensis* Nehring) depredation on Agroforestry System in Mt. Makiling Forest Reserve, Laguna, Philippines

[a*]Russel Son A. Cosico, [b]Leonardo M. Florece,
[c]Roberto G. Visco, [d]Juancho B. Balatibat

ABSTRACT

The assessment of social and economic impacts of Philippine warty pig (Sus philippensis Nehring) depredation on agroforestry crops was studied at the Mount Makiling Forest Reserve (MMFR) in 2012. This was done through structured survey among the farmer-respondents and farm monitoring to locate the physical damages caused by warty pig using Global Positioning System (GPS). The attitudes of farmers toward warty pig damage were analyzed based on symmetric five-point scale from strongly disagree to strongly agree. A total of 160 farmers were interviewed, however, only 50 farmers were affected by warty pig depredation on crops.

Results showed that tubers are the main diet of Philippine warty pig. Damaged root crops include gabi (Colocasia esculenta (L.) Schott), cassava (Manihot esculenta Crantz), ginger (Zingiber officinale Roscoe), sweet potato (Ipomoea batatas (L.) Lam.), and ubi (Dioscorea alata L.), either through direct foraging or trampling. Estimated monetary losses from annual root crops was greatest in ubi amounting to PhP 7,712.60 ha^{-1} yr^{-1} while the least was in ginger (PhP 105.00 ha^{-1} yr^{-1}) across the affected farmer-respondents. The physical evidences found were footprints/tracks, wallowing, bark injury due to their tusks, rest area/beddings and rooting.

With regards to farmers' perception on the damage of warty pig, only 20% strongly agreed on the occurrence of serious damage while more than one-third (42%) of the farmers are providing significant protection to their agroforestry crops/ farm. The existence of woody perennials provides another source of income for the household in the event of warty pig damage on the root crops. Agroforestry provided protective functions on farming inside MMFR.

Key words: crop depredation, monetary losses, warty pigs

INTRODUCTION

The presence of communities in protected areas such as Mount Makiling Forest Reserve (MMFR) is not new in the Philippines. Most often, inhabitants have been in the forests long before these were proclaimed as national parks or protected areas. Sometimes, the law has become a remedy to settle social conflicts versus further devastation of the reserve area. One example is the enactment of the National Integrated Protected Areas Act (NIPAS) of 1992 or Republic Act 7586. The NIPAS Act directly involves the community in its decision-making on how a protected area will be protected from further destruction. In MMFR for instance, Cruz *et al*. (1991) reported that 19 families followed by relatives and friends cleared part of the reserve on the Sto. Tomas, Batangas area in the early 1900s due to limited opportunities in the lowland.

According to Duldulao (1975), farmers inside MMFR practiced planting of agricultural crops and perennial crops. Farm lots are situated mostly along the periphery or along the boundaries of MMFR because of accessibility to secondary roads and their suitability to farming (Abraham *et al*. 1992). The practice and technology of combining forestry species with agricultural components including livestock is termed as agroforestry. It is defined as a dynamic, ecologically based natural system through the integration of trees in farmland and rangeland, diversifies and sustains production for increased social, economic and environmental benefits for land users at all levels (ICRAF 1997 as cited by Visco 2000).

Agroforestry is a farming system that integrates crops and/or livestock with trees and shrubs. The resulting biological interactions provide multiple benefits, including diversified income sources, increased biological production, water conservation, and improved habitat for both humans and wildlife. Farmers adopt agroforestry practices for two reasons: 1) they want to increase their economic stability; and 2) they want to improve the management of natural resources under their care (Beetz 2002).

While farming inside MMFR started as early as 1900s or even before it was under the administration of UPLB, no adequate records of wildlife attack on farm lots have been reported. For instance, Peñalba *et al*. (1997) mentioned facts about the progress of MMFR on cropping systems but no record or even study of wildlife intrusion on individual farm lots was reported.

Aside from having diverse ecosystems, MMFR is also home to wild animals, more specifically the Philippine warty pig. Different wild pig species occupy an extremely wide range of habitat types, where they feed opportunistically on plant/crops and animal species such as the young of larger mammals, and the eggs and young of ground-nesting birds and reptiles (Hamrick *et al*. 2011). They have the highest reproductive rates among ungulates, and if the reproductive requirements are met,

[a] University Researcher I, Institute of Agroforestry, CFNR, UPLB
[b]Professor, School of Environmental Science and Management, UPLB
[c]Professor, Institute of Renewable and Natural Resources, CFNR, UPLB
[d]Assistant Professor, Forest Biological Sciences, CFNR, UPLB
*Corresponding author: racosico@up.edu.ph

their local density can double in one year (Massei & Genov 2004). Consequently, the widespread increase in number and geographical range of this species might have a remarkable impact on many plant and animal species, habitat structure, and crop and livestock production. Wild pigs spend a large amount of time rooting for tubers, roots, bulbs, and invertebrates.

In terms of species diversity for wild pig, the Philippines is the second most important country in the world next to Indonesia (Cariño 1998). The wild pig has become endangered due to continuing destruction of its habitat and extreme hunting pressure coupled with illegal logging and slash and burn upland farming. The open areas for farming inside forested areas or reserve area as in the case of MMFR, created a secondary association in disturbed areas. The proximity of cultivated food stuffs and wanton destruction of its habitat has caused wild pigs to forage in neighboring agricultural lots (Catibog-Sinha 1978, 1981 as cited by Oliver *et al*. 1993).

Usually, they forage in the early morning and evening. Pigs in general are very prolific. They breed anytime of the year. Males are polygamous and establish harem during the breeding period. This harem could grow to as much as five sows per boar. Females are polyestrous and farrow usually in April or May. Gestation period lasts from 101-130 days with an average of 116 days or about four months. They produce an average of 3-4 piglets per litter (PAWB 1992 as cited by Cariño 1998). The Luzon wild pigs normally feed on rootstocks like gabi and camote which are considered carbohydrate-rich food (Rabor 1986).

This study evaluated the onsite crop depredation by Philippine warty pig on the farms in MMFR based on farmers' account or recollection. Specifically, it validated the presence of Philippine warty pig based on physical evidences; estimated monetary losses incurred by farmers; and assessed farmers' knowledge and attitudes toward Philippine warty pig damage.

METHODOLOGY

Place of Study

The study was conducted in MMFR, situated at 14°08'N latitude and 121°11'E. MMFR is surrounded by the municipalities of Los Baños and Bay, and city of Calamba in the province of Laguna and Sto.Tomas in the province of Batangas (Figure 1).

It occupies a total land area of 4,244.37 has. Los Baños, Bay, Calamba, and Sto. Tomas occupy the north central, southeastern, northwestern, and southwestern portions of the reservation, respectively. A total of 21 barangays are within the vicinity of the forest reserve. The town of Los Baños occupies the largest area with 46.7%, followed by Bay with 23.0%, Sto. Tomas with 16.9%, and lastly, the city of Calamba with 13.25%. Barangay Bagong Silang of Los Baños is the only barangay located inside MMFR (UPLB-MMFR 2005).

Conceptual Framework

The complicating land uses in MMFR have affected the way farmers perceive the presence of warty pigs. Farmers view them as pests, while warty pigs compete for space to survive. Lack of food availability inside MMFR during the rainy season has made them modify their behavior in search for food. Most of them browse through existing croplands inside the reserve for food consumption.

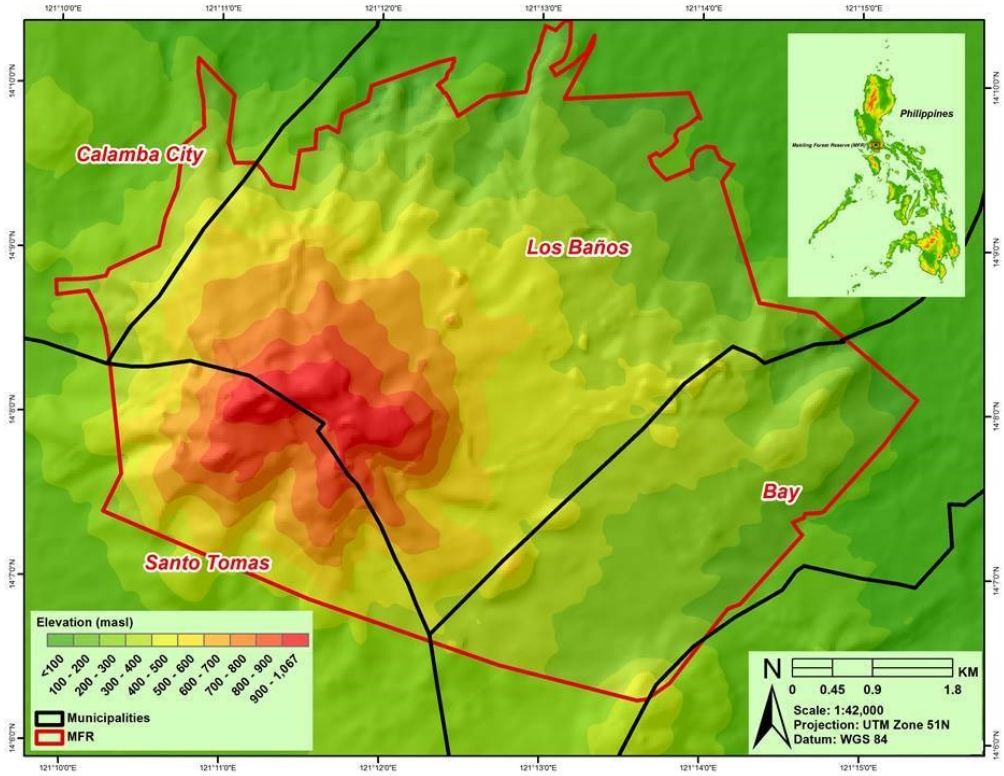

Figure 1. Location map of Mount Makiling Forest Reserve

Figure 2 shows the relationship between agroforestry systems and Philippine warty pig and its impacts on agroforestry system to upland farmers and vice versa. It shows the relationship among the key components of the study, namely farmers, warty pigs and agroforestry system. Farmers negatively perceive the presence of warty pigs as the threat to their harvest and will eventually affect their economic return from planting agricultural crops. Warty pigs consider farm lots as part of their area of movement and consume crops as source of their food.

Agroforestry is practiced by the farmers as a main source of their livelihood. It provides enough income to support their daily needs. With the intrusion of warty pigs in their farm lots, it made farmers realize the need to modify their farming practices so as not to be affected by warty pig attack on their farms.

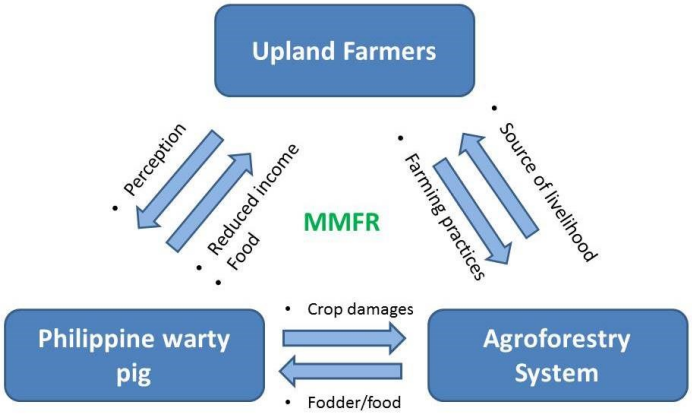

Figure 2. Conceptual framework of the study

Survey

There are 160 farmer respondents in this study (Table 1). Respondents are farmers cultivating farms within MMFR and on its buffer zone. Primary data were collected through surveys and key informant interviews using a structured interview questionnaire modified from previous studies. Data collection started from October to December 2012. Farm guides helped to identify farms within the specified barangays. Location of the farm lots was determined with the use of GPS.

Table 1. Number of respondents in each barangay.

Area	Frequency	Percent
Los Banos, Laguna		
Bagong Silang	69	43
Lalakay	53	33
Calamba City		
Pansol	11	7
Puting Lupa	8	5
Sto. Tomas, Batangas		
San Bartolome	17	11
San Rafael	2	1
Total	**160**	**100**

Tracking of presence of warty pig

Indirect methods were adopted to verify the presence of Philippine warty pig in MMFR. Physical evidences such as footprints/tracks, feces, rooting activities, and others were recorded and photo-documented. Whenever physical evidences were sighted, the location was obtained using GPS. Distance from the forest was not considered because warty pigs are mobile and therefore could travel far distances in search of food. Transect walk with an equivalent length of at least 1 km was employed in this study. Five transects were established in the study site. The specific time of transect sampling and the location of evidences were based on farmers' sighting of the Philippine warty pig signs as well as on the field guide's knowledge. The population of warty pig in MMFR was estimated by farmers.

Monetary Losses

Estimated average annual monetary losses from warty pig (WP) depredation as indicated by the farmer-respondents were computed based on the expected average of total volume harvested (TVH) per ha and average total volume damaged (TVD). The following formulas were used to compute losses:

Net volume harvested = Average TVH - Average TVD

Expected average total income (ATI) = Expected Average TVH x Price

Total income loss due to WP = Average TVD x Price

Income left due to WP damage = Expected ATI – Total Income Loss due to WP

Data Analysis

Descriptive statistics such as frequency, counts and percentages were used in the analysis of the results. Physical evidences of Philippine warty pig were documented and specific farm locations were mapped using Quantum GIS.

RESULTS AND DISCUSSION

Presence of Philippine Warty Pig in MMFR

Wild pigs are opportunistic generalists with regard to diet and habitat; consequently, their home range size may depend on a number of factors, including habitat quality, food availability, and population density (West *et al*. 2009). Poor habitat quality, limited food availability, and low population density lead to larger home ranges. Human activity can greatly impact home ranges as pigs reduce movements and home ranges in situations where human activity is high (Wood & Brenneman 1980; Hayes 2007; Gaston 2008 as cited by West *et al*. 2009).

Warty pigs could not be easily seen in the wild or forest. They are very sensitive animals and could easily notice the presence of humans. Counting the direct population of Philippine warty pig inside the reserve requires time and financial resources.

The criteria set for the assessment of warty pig population were low (<50 heads), medium (51-100 heads), and high (> 100

heads). Based on farmers' accounts, the estimated population of Philippine warty pig in MMFR is reflected in Table 2. Nearly half (47%) of the farmers positively answered that Philippine warty pigs in the forest was high (about >100). Meanwhile, 41 farmers (26%) rated the warty pig population as low (<50). On the other hand, 29 farmers (18%) who were farther from their farms had no idea and did not give an estimate. Two (1%) farmers said that WP could range from 200-300 individuals while another two farmers (1%) believed that its population was about 1,000 individuals.

Table 2. Respondents' estimate of the population of Philippine warty pig in MMFR.

Population	Frequency (n=160)	Percent
< 50	41	26
51-100	11	7
> 100	75	47
200-300	2	1
1000	2	1
No idea	29	18

Evidences of warty pigs' presence in MMFR were recorded during field visits. Based on the data, population of warty pig may fall under < 50 heads (Table 3). However, according to almost half of the respondents, its population was more than 100 heads (Table 2). Farmers' estimate may be considered more reliable since some of the evidences may not be present and were not recorded during data gathering. Furthermore, farmers' recollection and personal encounters could be more accurate than the recorded data during field visits since they stay longer in the area where warty pigs are present. However, 41 farmers who answered < 50 may also be accurate. The group of warty pigs that attacked a particular farm may also be the same group that affected other farms.

Farmers who experienced crop damage rated the population of Philippine warty pig as high. In the study of Garshelis *et al*. (1999), persons who reported bear damage at East-Central Minnesota were much more likely to rate the bear population as high and less likely to rate the population as low than individuals who had not experienced damage.

Wild pig populations have incredible potential for clan expansion. In good habitat conditions, adult females can farrow multiple times per year and produce large litters and juvenile females can breed at an early age. As a result, pig populations can grow quickly and expand their range in numbers.

Table 3. Frequency of surveyed evidences of Philippine warty pig in Los Baños Calamba, and Batangas from October to December 2012.

Evidences	Frequency
Footprint	5
Rooting activity	5
Mud bath/wallow	2
Bark removal	1
Rest area	2

Wild pigs generally travel in large family groups, often called "sounders," consisting of several adult females and multiple juveniles. These sounders consist of up to three related generations and typically number eight or fewer individuals with one to three adults (West *et al*. 2009).

To validate the farmers' estimate of the warty pig population, the study observed physical evidences of the presence of warty pig in the forest. Wild pigs leave field signs that are unique and identifiable, thus making it relatively easy to determine whether wild pigs inhabit an area (West *et al*. 2009). Signs of Philippine warty pigs' presence were manifested through their footprints/ tracks, wallowing, bark damage due to their tusks, rest area/ beddings, and rooting. Unfortunately, no fecal remains were found during the conduct of the field work. The evidences found are shown in Figures 3 to 7.

Mud rubs on trees are a good indicator of their presence and can give an idea on the relative size of warty pigs in a particular area. They rub their bodies on trees to remove excess mud from

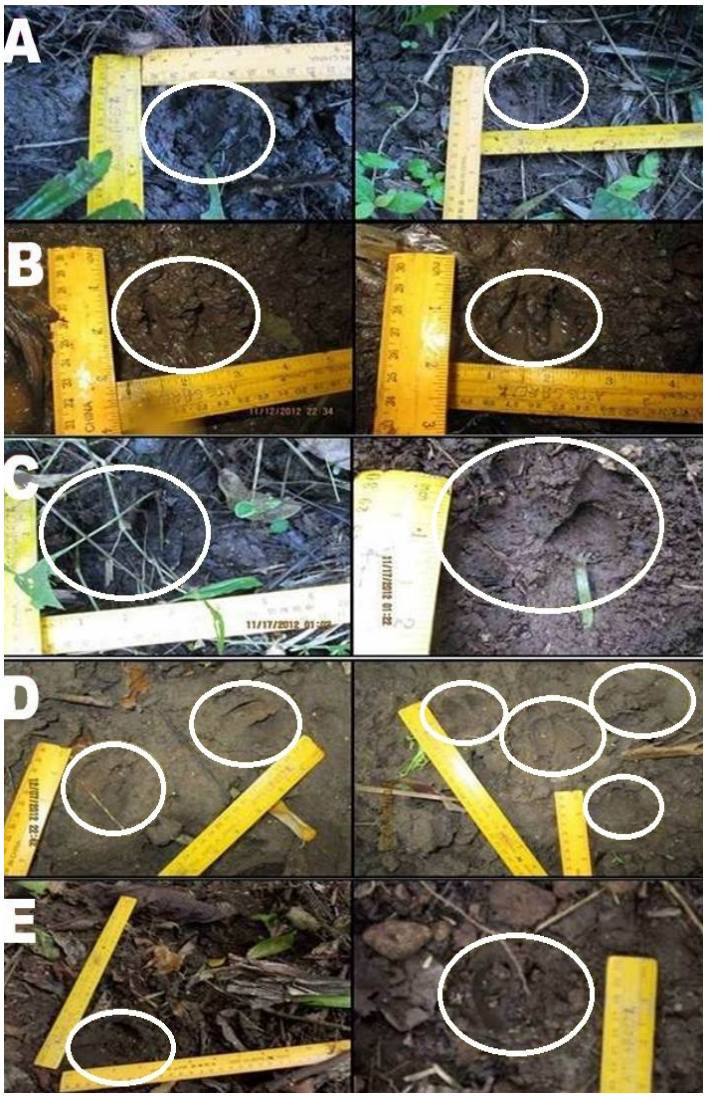

Figure 3. Foot printstracks of warty pigs as observed in one of the respondent's farm lot sighted at (A) Bagong Silang, (B) Lalakay, (C) Puting Lupa, (D) San Bartolome and (E) San Rafael

Figure 4. Warty pigs create wallow as observed as (A) Lalakay, Los Baños, and (B) San Rafael, Batangas

their coats after wallowing. Mud rubs three to four feet off the ground indicate the presence of mature pigs (West *et al*. 2009). Male wild pigs use their tusks to remove the bark and expose the wood of small trees as part of their scent marking behavior. In addition, rooting is the most common and recognizable field sign created by wild pigs (West *et al*. 2009). Figure 5 shows evidences of damage on tree bark of mahogany made by warty pigs in Barangay San Rafael.

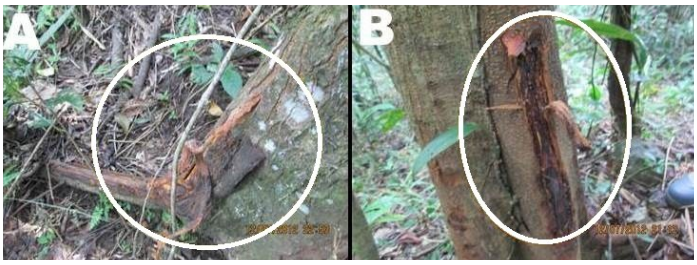

Figure 5. Damage on a portion of bark of Mahogany caused by warty pig as observed at San Rafael, Batangas

Wild pigs spend a good deal of time wallowing in ponds, springs, or streams, usually in or adjacent to dense brush or marsh vegetation during periods of hot weather (Barrett & Birmingham 1994). Based on field visits, the Philippine warty pig traverse the steep area covered with grass and shrub vegetation. Table 3 and Figure 6 show the number and location of surveyed evidences of warty pigs, respectively. Evidences were found in Barangays Bagong Silang, Lalakay, Puting Lupa, San Bartolome, and San Rafael. No evidences were found in Barangay Pansol, Calamba but the farmers claimed that crops damaged by warty pig were observed in the previous year (2011). The evidences were significant in Barangay San Rafael because warty pigs developed familiarity within the area which used to be cultivated and where they have ample space to move around. The farmer respondents experienced crop damage 10 years ago, but they still confirmed the presence of warty pigs in the reserve at the time of the study.

On the other hand, farm lots in San Bartolome are far from MMFR, approximately two km but farmer–respondents also confirmed the presence of warty pigs. Evidences found in Barangay San Bartolome were also sighted in the forested area (Figure 7). Footprints and rootings were the most significant evidences observed in the agroforestry farms in Barangays Bagong Silang, Lalakay, and Puting Lupa (Figure 8). Site visits in Barangays Bagong Silang and Lalakay showed that only one

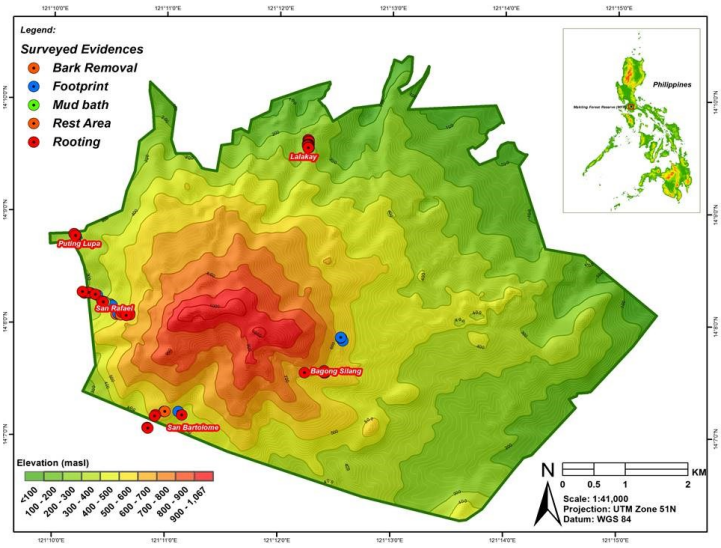

Figure 6. Map showing the surveyed evidences of Philippine warty pig in MMFR

Figure 7. (A) Warty pigs' rest area and (B) constructed beds—a warty pig is about to give birth at San Bartolome and San Rafael, Batangas

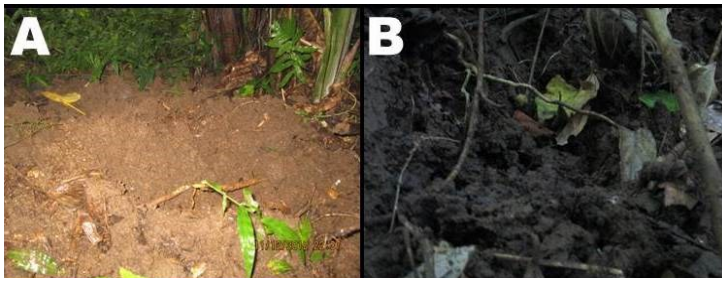

Figure 8. Philippine warty pig rooting activity in one of the respondents' farm lot as observed at (A) Lalakay and (B) Bagong Silang, Los Baños

farm had evidences of the presence of warty pigs. This could be due to timing of the site visit, wherein evidences on other farm lots may have been washed out by rains. Another reason could be that warty pigs' tracks were trampled long before the conduct of the study. In Barangay Puting Lupa, only one farmer experienced warty pig attack on his farm at the time of the study. Other farmers experienced warty pig attack in 2011. Warty pigs attack and consume root crops. The feeding mechanism starts from rooting up and then chewing the roots and tubers. Warty pigs normally visit the farm when there is no human on site.

Based on the location of evidences, the estimated distance of Barangay Puting Lupa to Barangay San Rafael is about 1.1 km, to Barangay San Bartolome 3.2 km, to Barangay Bagong Silang 4.5 km, and to Barangay Lalakay 4 km. The group of warty pigs may also be the same group that visited Barangay San Rafael and Barangay San Bartolome, but it could also be a different group that visited Barangays Bagong Silang and Lalakay. The longest estimated distance between barangays was 5 km (Barangay Lalakay to Barangay San Bartolome) and the shortest was 1.1 km (Barangay Puting Lupa to Barangay San Rafael) (Table 4).

Table 4. Estimated distance of evidences from one barangay to another barangay.

	B. Silang	Lalakay	Puting Lupa	San Bartolome	San Rafael
Bagong Silang	-	3.8 km	4.6 km	2.7 km	3.8 km
Lalakay	3.8 km	-	4.0 km	5.0 km	4.2 km
Puting Lupa	4.6 km	4.0 km	-	3.2 km	1.1 km
S. Bar-tolome	2.7 km	5 km	3.2 km	-	2.0 km
San Rafael	3.8 km	4.2 km	1.1 km	2.0 km	-

Crop damage by Philippine warty pig

The number of farmers who experienced damage to their crops due to Philippine warty pigs is shown in Table 5. Five out of six selected barangays were affected. Only 50 (31%) out of 160 farmer-respondents confirmed the attack of warty pigs on their crops. Zero crop damage was recorded in Barangay San Bartolome, Batangas since their farms were far from the reserve. The risk of crop damage by warty pig may be influenced by the distance of the farm from roads and human habitation. According to farmers' estimates, the average distance of farm lots to the nearest road and farmers' house were 0.93 km and 1.36 km, respectively. Figure 9 shows the location of farm lots and surveyed evidences of Philippine warty pig.

Farms that were far from the reserve experienced fewer disturbances. Nonetheless, farmers who experienced zero disturbances still claimed that warty pigs exist in MMFR. Out of those with disturbance, 80% had farm lots adjacent or < 1 km distance from the natural forest and only few farms whose farm lots were located > 1 km. Crop damage by warty pigs was observed from a distance ranging from 0-5 km with an average distance of 0.5 km or 500 meters from MMFR (Table 6).

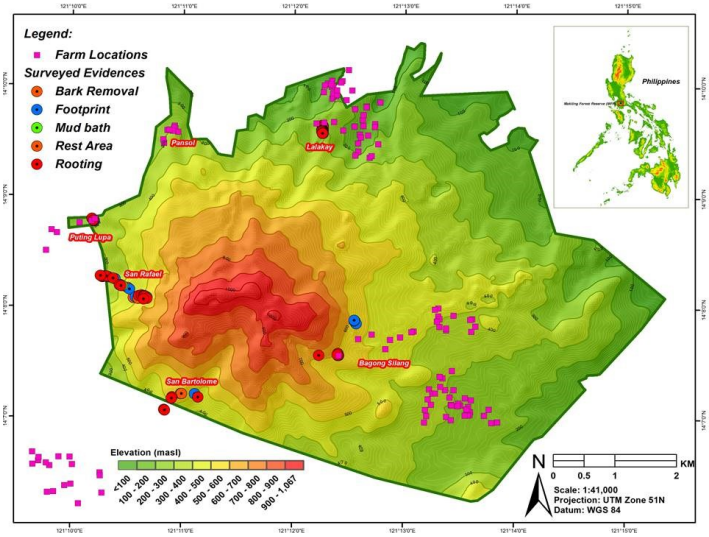

Figure 9. Location of farm lots and surveyed evidences of Philippine warty pig in the MMFR

Table 6. Farmers' estimated distance of agroforestry farm lots to the natural forest.

Distance of farm to forest	Frequency (n=50)	Percent
Adjacent - <1km	40	80
1- >5km	10	20
Average: 0.5 km or 500 m		
Range: 0-5 km		

Farm crops damaged by Philippine warty pig

All of the 50 farmer-respondents said that gabi was the major crop damaged by warty pig followed by cassava (44%), ubi (34%), newly planted coconut (22%), and sweet potato (10%). The warty pig raids farms when crops are mature. Many wild boar populations cause substantial damage to agricultural crops, particularly when energy-rich food is scarce (Mackin 1970; Anderzjewski & Jezierske 1978 as cited by Massei & Genov 2004). Furthermore, Schley & Roper (2003) say that wild boar prefers fresh crops because these are juicy, easy to digest, and provide more energy.

The farmer-respondents observed high records of attacks during the months of April–May and October–November, usually when crops are ready for harvest. Attacks were usually made during nighttime or when farmers had already left their farm. The same observation was reported in Australia because wild boars are primarily nocturnal (Saunders & Kay 1991; Caley 1997 as cited by Campbell & Long 2010).

Table 5. Number of farmers who experienced damage to their crops due to Philippine warty pig.

Farmers who experienced crop damage	CALAMBA		LOS BAÑOS		STO.TOMAS		TOTAL	Percentage
	Pansol	Puting Lupa	Bagong Silang	Lalakay	San Bartolome	San Rafael		
Yes	6	5	14	23	0	2	50	31.25
No	5	3	55	30	17	0	110	68.75
Total	11	8	69	53	17	2	160	

Table 7 shows the most commonly observed damages to farmers' crops. Of the 50 out of 160 farmer-respondents who experienced warty pig attacks on their crops, nearly one-fourth (22%) claimed that damages were observed on young plants. Five (10%) farmers claimed that damage was evident on mature grains while one farmer (2%) specified damage on banana plantation (Figures 10 to 12).

Table 7. Number of farmers who observed type or parts of crops damaged by Philippine warty pig.

Type of Damage	Number (n=50)	Percent
Tubers eaten	50	100
Mature grain or fruits eaten	5	10
Young plants eaten	11	22
Damaged newly planted trees	11	22
Others (damaged banana stem)	1	2

Figure 10. Fallen banana believed to be caused by Philippine warty pig at agroforestry farm in Lalakay, Los Baños

Figure 11. Philippine warty pig damage on young plants at agroforestry farms in (A) Bagong Silang and (B) Lalakay, Los Baños

Figure 12. Evidences showing tubers as the preferred diet of Philippine warty pigs at the forested areas in (A) San Rafael, Batangas and (B) agroforestry

Monetary loss due to Philippine warty pig depredation

Warty pigs can cause serious damage to crops in a single farm visit as shown in this study. The study of Perez and Pacheco (2005) showed that peccaries may cause great damage in a single visit; for example, they can depredate about 40 walusa (*Colocasia esculenta*) plants in one single intrusion to an enclosure. Peccaries are any of several largely nocturnal gregarious American mammals resembling and related to pigs.

Respondents observed different counts of warty pigs entering their farms in a single visit. Nearly one-third (32%) of the farmers observed 3-4 warty pigs while 15 farmers (30%) estimated 5-6 heads visited their farm. Three farmers (6%) reported more than 10 heads of warty pigs entered the farm lots (Table 8).

Table 8. Number of farmers who estimated the population of warty pigs entering farm lots.

Population	Number (n=50)	Percent
1-2	4	8
3-4	16	32
5-6	15	30
7-8	7	14
9-10	5	10
>10	3	6
Total	50	100

Table 9 shows the estimated monetary losses due to warty pig attack. These were based on data from 2007–2012 wherein 42 farmer-respondents' farms were affected by foraging and trampling by warty pigs. The eight other respondents had damage to their farms prior to the research duration. The expected average volume of harvest for cassava was 228.61 kg^{-1} ha^{-1} yr^{-1} with a farm gate price of PhP 8.00 kg^{-1}. The expected average total income for cassava was PhP 1,828.88 ha^{-1} yr^{-1}. Due to warty pig damage, the remaining income was only PhP 122.24 ha^{-1} yr^{-1} and its corresponding total volume of damage was 213.33 kg^{-1} ha^{-1} yr^{-1}. The equivalent total income loss from cassava amounted to PhP 1,706.64 ha^{-1} yr^{-1} (93%).

The expected average TVH for gabi was 228.93 kg^{-1} ha^{-1} yr^{-1} but wild pig depredation volume of damage was recorded at 179.52 kg^{-1} ha^{-1} yr^{-1}. The average total income expected for gabi was PhP 1,831.44 ha^{-1} yr^{-1} but only PhP 395.28 ha^{-1} yr^{-1} was left. Therefore, expected ATI loss for gabi alone was PhP 1,436.16 $^{-1}$ ha^{-1} yr^{-1}. The farm gate price per kilogram of gabi during the conduct of the study was PhP 8.00.

Ginger was not spared from warty pig damage although it had the least damage with only 16.47%. Results revealed that an average TVH for ginger was 42.5 kg^{-1} ha^{-1} yr^{-1}. Since farmers seldom plant ginger and it is not intercropped with other tubers, trampling was observed. Warty pig attack had less impact on ginger and the average TVD was only 7 kg^{-1} ha^{-1} yr^{-1} with a corresponding farm gate price of PhP 15.00 kg-1. The average total income from ginger was PhP 637.50 ha^{-1} yr^{-1} and the average TVD was PhP 105.00 ha^{-1} yr^{-1}. The net income from ginger was PhP 532.50 ha^{-1} yr^{-1}.

Table 9. Estimated monetary loss due to Philippine warty pig from year 2007-2012 (n=42).

Crops	Expected Average TVH (kg)	Ave. TVD (kg)	NVH (kg)	Farm gate price in kg in PhP	Expected average Total income (ATI) in PhP	Total income loss due to WP in PhP	Income left due to WP Damage in PhP	% Damage
Cassava	228.61	213.33	15.28	8.00	1,828.88	1,706.64	122.24	93.32
Gabi	228.93	179.52	49.41	8.00	1,831.44	1,436.16	395.28	78.42
Ginger	42.50	7.00	35.50	15.00	637.50	105.00	532.50	16.47
Sweet Potato	458.00	454.00	4.00	15.00	6,870.00	6,810.00	60.00	99.13
Ubi	403.75	385.63	18.12	20.00	8,075.00	7,712.60	362.40	95.51

The warty pig heavily damaged sweet potato with an expected average TVH of 458 kg^{-1} ha^{-1} yr^{-1} and expected ATI of about PhP 6,870.00 ha^{-1} yr^{-1}. Average TVD of 454 kg^{-1} ha^{-1} yr^{-1} with PhP 6,810.00 ha^{-1} yr^{-1} total income losses with only 4kg^{-1} ha^{-1} yr^{-1} was left. Therefore, PhP 60.00 was left for the farmer. The farm gate price of sweet potato was PhP 15.00 per kg^{-1}.

Another root crop that was heavily affected was ubi. The expected average TVH for ubi was 403.75 kg^{-1} ha^{-1} yr^{-1} and the farm gate price was PhP 20.00 per kg^{-1}. The expected total income was PhP 8,075.00 ha^{-1} yr^{-1} but only PhP 362.40 ha^{-1} yr^{-1} was left. After deducting the damage, the average TVD was 385.63 kg^{-1} ha^{-1} yr^{-1}. The average total income loss for the farmer was PhP 7,712.60^{-1} ha^{-1} yr^{-1}. The highest monetary loss or damage among the root crops was ubi which had the highest farm gate price.

Sweet potato was the most heavily damaged (99.13%) among other crops as it had the largest volume of standing crops injured by the warty pig. Ubi was the second most damaged crop with 95.51%. Sweet potato and ubi also obtained the highest expected average total income since its gate price was also higher than cassava and gabi. Conversely, ginger had the lowest percentage of damage with 16.47% because it is not the preferred forage of warty pigs.

Based on the results, damage caused by warty pigs is mainly on the agricultural crop component of the agroforestry system inside MMFR. Agroforestry system promotes other sources of livelihood and income from fruit trees and other root crops which are not susceptible to physical damage of warty pigs. In the event that agricultural crops are damaged due to wildlife attack, the farmers can augment their income from non-agricultural agroforestry components such as perennial crops (Table 10).

Philippine warty pig diet from the natural forest

The preferred species of the Philippine warty pig for their diet found inside MMFR according to the farmer-respondents are listed in Table 11. Pili (*Canarium ovatum* Engl.), *piling gubat* (*Canarium sp.*), wild banana (*Musa spp.*), and *pongapong* (*Amorphophallus paeoniifolius* (Denntedt) Nicolson) are some of the preferred wild plants eaten by warty pigs. They also feed on any fallen wild fruits. Farmers (13%) whose farms were farther from the forest replied that they had no idea on the warty pigs' diet.

Among the domesticated plants, the warty pig preferred root crops (tubers) for food. Gabi was the favorite (48%), followed

Table 10. Farmers' list of perennial crop species raised in the farm lots.

Perennial Crop Species	Scientific Name
Atis	*Annona squamosa* L.
Avocado	*Persea gratissima* Gaertn.
Bamboo	Poaceae sp.
Banana	Musa spp.
Biriba	*Rollinia mucosa* (Jacq.) Baill.
Cacao	*Theobroma cacao* L.
Chico	*Manilkara sapota* (L.) Royer.
Coconut	*Cocos nucifera* L.
Coffee	*Coffea arabica* L.
Duhat	*Syzygium cumini* (L.) Skeels
Durian	*Durio zibethinus* Murr.
Guava	*Psidium guajava* L.
Guyabano	*Annona muricata* L.
Jackfruit	*Artocarpus heterophyllus* Lam.
Kaimito	*Chrysophyllum cainito* L.
Kalamansi	*Citrofortunella microcarpa* (Bunge) Wijnands
Kasoy	*Anacardium occidentale* L.
Lanzones	*Lansium domesticum* Correa
Mango	*Mangifera indica* L.
Papaya	*Carica papaya* L.
Rambutan	*Nephelium lappaceum* L.
Santol	*Sandoricum koetjape* (Burm. f.) Merr.
Sintunis	*Citrus reticulata* Blanco
Suha	*Citrus maxima* (Burm.) Merr.
Tamarind	*Tamarindus indica* L.
Tiesa	*Pouteria rivicoa* (Gaertn.f.) Ducke

Table 11. Plants identified by farmers that serve as food for Philippine warty pig inside MMFR.

	SCIENTIFIC NAME	FREQUENCY (n=160)	%
WILD PLANTS			
Apitong	*Dipterocarpus grandiflorus* Blanco	3	2
Balete	*Kingiodendron alternifolium* (Elmer) Merr. & Rolfe	3	2
Balobo	*Diplodiscus paniculatus* Turez.	1	1
Kamatis-kamatisan	-	11	7
Kaong	*Arenga pinnata* (Wurmb) Merr.	8	5
Katmon	*Dillenia philippinensis* Rolfe	5	3
Mabolo	*Diospyros blancoi* A. DC.	4	3
Malaruhat	*Syzgium subcaudatum*	1	1
Niyog-niyogan	*Ficus pseudopalma* Blanco	1	1
Pangnan	*Lithocarpus sulitii* Soepadmo	1	1
Pili	*Canarium ovatum* Engl.	24	15
Piling gubat	*Canarium sp.*	11	7
Piling liitan	*Canarium luzonicum* (Blume) A. Gray	2	1
Pongapong	*Amorphophallus paeoniifolius* (Denntedt) Nicolson	10	6
Pugahan	*Caryota cumingii* Lodd.	4	3
Tanguile	*Shorea polysperma* (Blanco) Merr.	3	1
Takulau	*Miliusa vidalii* Sinc.	1	1
Tibig	*Ficus nota* (Blanco) Merr.	1	1
Ulayan	*Lithocarpus llanosii* (Blume) A.DC.	2	1
Wild banana	*Musa spp.*	11	7
Wild rambutan	-	4	3
Any fallen wild fruits	-	21	13
DOMESTICATED PLANTS			
Avocado	*Persea gratissima* Gaertn.	1	1
Cassava	*Manihot esculenta* Crantz	20	13
Coconut	*Cocos nucifera* L.	21	13
Gabi	*Colocasia esculentum* (L.) Schott	77	48
Santol	*Sandoricum koetjape* (Burm. f.) Merr.	1	1
Sweet potato	*Ipomea batatas* (L.) Lamk.	21	13
Tiesa	*Pouteria rivicoa* (Gaertn.f.) Ducke	1	1
Ubi	*Dioscorea alata* L.	2	1
No idea	-	21	13

by cassava (13%), sweet potato (13%), and coconut (13%) as recounted by the farmers.

The farmer-respondents also reported evidences that warty pigs feed not only in their farms, but also inside the forest. About 87% of the respondents said that wild plants are abundant inside MMFR while 13% of the farmers had no idea (Table 12).

Table 12. Farmers' opinion on abundance of wild plants inside the reserve.

Abundance	Frequency (n=160)	Percent
Yes	139	87
No	0	0
No idea	21	13

According to the farmers, warty pigs prefer tubers (51%), fruits (41%), young plants (14%), and coconut meat (5%). The rest (13%) of the farmers had no idea on the food preference of warty pigs (Table 13).

Table 13. Warty pigs' preferred plant part consumed inside MMFR.*

Parts Eaten	Frequency (n=160)	Percent
Tubers	81	51
Fruits	66	41
Young plants	23	14
Coconut meat	8	5
No idea	21	13

On whether the family spends much time in protecting their farm crops, 46% disagreed, 42% agreed, and 8% strongly agreed. Asked if warty pigs strongly affected their life, 36% of the farmers agreed, 14% strongly agreed, and 44% disagreed (Table 14). Those who disagreed have been practicing agroforestry. They not only planted root crops but also fruit trees as a source of alternative livelihood. Although all affected farmers have been practicing agroforestry, the farmer-respondents who agreed that warty pig damage strongly affected their life, planted more agricultural crops than fruit trees. This is based on the physical observation of the farms wherein monocropping of agricultural farms showed evidences of more significant damage as indicated in the Figure 12. Since agroforestry entails intercropping of woody perennials which are already in their mature stage during the conduct of the study, these were not susceptible to warty pig foraging.

The results of this study are consistent with the findings of Olujobi *et al*. (2013), which show that agricultural root crops are susceptible to warty pig damage. The diversity of the agroforestry farm with sturdy and vigorous farm components such as fruit trees makes it more resistant to physical plant damage from mammalian pests. Moreover, a combination of the different crops provides different production cycles of food crops resulting to uninterrupted supply amidst physical, biological and environmental disturbances ensuring certainty of secured harvest (Nair 1993).

Table 14. Farmers' opinions regarding damage caused by Philippine warty pig (n=50).

	Strongly Disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
Warty pig caused serious damage to my agroforestry crops/farm	5 (10%)	4 (8%)	3 (6%)	28 (56%)	10 (20%)
My family spends much time protecting our agroforestry crops/farm	1 (2%)	23 (46%)	1 (2%)	21 (42%)	4 (8%)
The warty pig damages strongly affected our life	1 (2%)	22 (44%)	2 (4%)	18 (36%)	7 (14%)

Agroforestry provides a diverse source of income compared to monocropping which relies solely on agricultural crops. Agroforestry practice can also lessen the time that farmers spend in protecting and monitoring their crops against attack of warty pigs.

CONCLUSIONS AND RECOMMENDATION

This assessment of the Philippine warty pig damage to crops or any wildlife is a pioneering study in MMFR. It provides baseline information on the state of Philippine warty pig in MMFR according to farmers' perspectives. The farmers observed that warty pigs still exist inside MMFR. They estimate that more than 100 warty pigs are roaming around MMFR and visiting their farm lots. Agricultural crops particularly tubers are the preferred diet of the Philippine warty pig and hence are the most damaged among the agroforestry crops.

Farmers perceive that there is still abundant source of food for the warty pigs inside the forest reserve. However, seasonal changes in the availability of food from the forest cause the warty pigs to search for alternative food in cultivated farms.

Direct and indirect methods of validating the presence of Philippine warty pig inside MMFR indicate their existence in the reserve. Farmers may have over- or under-estimated the amount of crops damaged due to lack of direct experience in assessing or documenting them.

Further research is recommended on the following:

1. Impacts of damage by Philippine warty pig in MMFR on a larger scale of the ecosystem. Focus should be on quantifying the extent (area in square kilometers to approximate income losses) of Philippine warty pig disturbances such as rooting, regeneration potential of

seedlings, and vegetation composition.
2. Direct measurement based on valuation is needed to avoid over- or under-estimation of the amount of damage.
3. Experimental plots must be established to determine the amount of crops damaged by Philippine warty pig and monitored for a longer study period to capture seasonal changes (summer and rainy seasons) and validate warty pigs' movement pattern in depredated farm lots.
4. Comparison between warty pig and other wildlife species regarding mode of their attack to crops is needed for better analysis.

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