Journal of Environmental Science and Management Special Issue 1-2016: 42-55 ISSN 0119-1144

Knowledge, Attitude and Practice of Smallholder Farmers Regarding Climate Change and Agroforestry: A Case Study of Farmers in Peñablanca, Cagayan

ABSTRACT

Climate change threatens to derail the lives and livelihoods of farmers all over the world if appropriate adaptation measures are not put in place. Smallholder farmers, more so those in developing countries like the Philippines, are especially at risk because of inherent socio-economic characteristic and environmental factors limiting their capacity to adapt. One adaptation measure that can potentially benefit smallholder farmers is agroforestry. However limited understanding, incorrect information and a negative mindset could hinder the successful adoption of this practice. This case study of smallholder farmers in Peñablanca, Cagayan, Philippines attempts to explain the farmers' adaptation practices by analyzing their knowledge and attitudes on climate change and agroforestry. Two sets of surveys, one on adaptation practices (n=600) and one on knowledge and attitudes (n=41) were conducted with smallholder farmers in Peñablanca. Most farmers are aware of the basic concepts of climate change (91%) and agroforestry (84%), specifically of the impacts of climate extremes on their farms and of the benefits of agroforestry. However this may not always translate to correct practice of agroforestry and other adaptation measures. It is recommended that information, education, and communication programs on climate change and agroforestry for farmers should present targeted information on impacts and adaptation in a way that is relatable and understandable to them.

Key words: *knowledge, attitude, climate change, agroforestry, smallholder farmers*

Regine Joy P. Evangelista[1*]
Amy Christine Cruz[1]
Rodel D. Lasco[1]

[1] World Agroforestry Centre – Philippines, 2F Khush Hall, IRRI Campus, College, 4031, Laguna, Philippines

E-mail: R.Evangelista@cgiar.org
(*corresponding author)

INTRODUCTION

Agriculture is considered as the most vulnerable sector to climate change because of its dependence on climate and weather (*ADB 2009*) and smallholder or subsistence farmers are the most at risk to the changing climate (*Vermeulen et al. 2012; Easterling et al. 2007*). *Morton* (*2007*) asserts that this high vulnerability to climate change impacts is often inherent to their location, which is usually in the rural and upland areas of developing countries like the Philippines. Moreover, smallholder farmers' capacity to adapt is limited by the present socio-economic, demographic and policy conditions that governs them (*Morton 2007*), including poverty and inaccessibility, and unavailability of social services.

Among the immediate and critical threats are extreme weather events and extreme climate events brought about by anthropogenic climate change (*IPCC 2012*). Climate extremes can directly affect farmers' lives and livelihoods by destroying crops and damaging properties, as well as indirectly through impacts on the accessibility and affordability of food and other basic goods and services.

Based on years of experience, smallholder farmers have evolved ways of adapting to extreme weather events. Adaptation helps ease the burden caused by climate change so they can continue their livelihood, and even benefit from the opportunities brought about by climate change (*Smit and Skinner 2002*). However, maladaptation may also occur, therefore there is a need for a thorough and holistic review of available adaptation measures and vulnerabilities of the implementing system, before appropriate recommendations can be made. In addition, the limited resources of smallholder farmers mean that their adaptation practices should be low-cost, strategic, and should also provide multiple benefits.

One such adaptation strategy for farmers is the use of tree-based farming systems, including agroforestry, which can provide a multitude of economic and ecological benefits (*Lasco et al. 2014a*; *Tolentino et al. 2010*). *Nair* (*2013*) describes agroforestry as the deliberate mixture of trees with crops and animals which gives increased production and ecological stability. Simply put, it is growing trees on farms.

The benefits of tree-based farming systems extend from providing timber, fruits, fuelwood and other products for consumption and/or additional income, to providing important ecosystem services that increase farmers' resilience to extreme events. More recently, the importance of trees and forests in climate change mitigation has also

been highlighted, thus making agroforestry a synergistic approach that addresses both adaptation and mitigation needs (*Lasco et al, 2014b*; *Easterling et al. 2007*).

Despite the numerous scientific studies and programs promoting the benefits of tree-based farming systems in countries like the Philippines (see *Bertomeu 2012 and 2006*, *Magcale-Macandog et al. 2010*, and *Pattanyak and Mercer 1998*), the extent of its actual practice among smallholder farmers is still uncertain (*Snelder and Lasco 2008*). This could be attributed to the wide variety of systems and practices that fall under the broad umbrella of agroforestry. Contour farming, forest farming, alley cropping and conservation farming are just some of the practices that are recognized as agroforestry. Indigenous groups also have local terms for tree growing practices, which makes the inclusion of such practices in studies more challenging. In addition, the integration of trees into farming systems or home gardens has been historically promoted as part of reforestation, tree planting or sustainable land use programs since the 1970s (*Snelder and Lasco 2008*), further obscuring the concept especially for farmers who are the main targets of such programs.

Limited knowledge of good agroforestry practices remains to be a barrier to the widespread practice of agroforestry in the Philippines, despite the different information, education, and communication (IEC) activities conducted by both the public and private sectors, (*Visco et al. 2011*). Even to farmers who are aware of agroforestry, their understanding is still limited when compared to the scientific concept of agroforestry, which means its benefits may not be maximized. For example, there is widespread misconception among farmers that agroforestry can only be applied in upland areas (*Visco et al. 2011*).

The same could also be said of climate change and climate change adaptation. Information dissemination on climate change and its impacts have also been in the agenda of various government and non-government agencies in the country, more so since the Climate Change Act of the Philippines (RA 9729) was enacted in 2009. However, knowledge may not always translate to the practice of appropriate and effective adaptation strategies, especially among farmers. A case in point is a study in North Luzon, Philippines which revealed the high awareness of climate change issues among smallholder farmers, however, the adoption of adaptation measures remain hindered by high costs, high labor requirements, difficulty in implementation (highly technical), and the need for more information (*Ngilangil et al. 2013*).

This case study attempts to explain the present adaptation practices of smallholder farmers in Peñablanca, Cagayan by exploring their knowledge, attitudes, and perceptions towards agroforestry and climate change. Understanding how farmers perceive climate change and whether or not they have a positive attitude towards it, can help shed light on their decisions on adopting a certain practice. Awareness or knowledge, attitudes and practices studies reflect a human side of the vast amount of scientific research and data on climate change and agroforestry, and could provide insight on how to effectively communicate climate change and agroforestry as an adaptation strategy to rural communities (*CARICOM 2006*).

MATERIALS AND METHODS

The Research Site

This paper focuses on research activities conducted by the World Agroforestry Centre-Philippines in the municipality of Peñablanca, situated in the southeastern part of Cagayan province in Northern Luzon. Peñablanca has a total land area of 124,565 ha which comprises about 13.26% of the total land area of Cagayan province, and a total population of 42,736 as of the 2010 census (NSO 2012). It is a first class municipality consisting of 24 barangays, with 15 classified as upland barangays and 21 classified as rural. Majority of the lands are forestlands (89.26%), while the rest are alienable and disposable (*Municipal Government of Peñablanca, Cagayan 2009*). It is traversed by various watersheds, the largest and most important of which is the Pinacanauan de Tuguegarao watershed which provides irrigation water to ricelands within Peñablanca and Tuguegarao, Cagayan. Much of Peñablanca forms part of the Sierra Madre mountain range and is protected under the National Integrated Protected Areas System (NIPAS) Act of 1992.

The province of Cagayan, including Peñablanca, is located within the typhoon belt and is considered as one of the most vulnerable provinces in the Philippines to extreme climate events, especially typhoons (*Baccay 2012*). Its residents depend chiefly on agriculture, cultivating corn, rice and other cash crops and keeping livestock in their backyards. However, majority are tenants or farm laborers (30.96% of the working population, according to the Municipal Planning and Development Office in 2012), with a few involved in the community-based forest management program of the government (*Bennagen et al. 2007*).

Peñablanca has also been a model site for conservation activities among government, non-government organizations (NGOs), and the private sector. In 2007, the Philippine Peñablanca Sustainable Reforestation Project

was established to prevent deforestation and restore ecosystems by providing incentives to local communities (*Toyota Motors Corporation and Conservation International Philippines 2009*). The municipality was also identified as one of the project sites for Philippine Climate Change Adaptation Project (PhilCAP), a World Bank-funded project by the Philippine government.

Data and Analysis

During the third quarter of 2012, a total of 600 farming households in Peñablanca chosen via stratified random sampling were surveyed across six barangays, all classified by the municipal government as upland. An 18-page questionnaire was administered to households identified through stratified random sampling via draw lots. In a later survey in September 2014, a small subset of the surveyed farmers and farmer leaders from four other barangays were invited to answer a short questionnaire on their knowledge, attitudes, and practices (KAP) towards agroforestry and climate change. The questionnaire included a true or false-type quiz and a series of questions that ascertained their knowledge and perspectives on the concepts and issues of climate change and agroforestry, as well as a 5-point Likert-scale test to determine the farmers' attitudes toward climate change adaptation and agroforestry. A total of 42 farmers answered the survey. Descriptive statistics were used to analyze the farmers' perceptions and attitudes and how it may affect their adaptation strategies and agroforestry practices.

The first survey to determine the farmers' adaptation and coping strategies to climate extremes was administered in six barangays in Peñablanca namely: Baliwag, Bugatay, Cabasan, Cabbo, Mangga and San Roque. The subsequent survey on knowledge and attitudes was then administered to farmers, farmer leaders, and staff of the barangay and municipal government from nine barangays in Peñablanca, including the aforementioned six plus Aggugaddan, Buyun, Minanga, Nabbabalayan, and Sisim and one respondent from Tuguegarao City (**Table 1**).

Table 1. Profile of respondents.

	Adaptation Survey (n=600)	**Knowledge, Attitude and Practices Survey (n=42)**
Location (Barangay)	Baliwag, Peñablanca (80) Bugatay, Peñablanca (108) Cabasan, Peñablanca (59) Cabbo, Peñablanca (97) Mangga, Peñablanca (139) San Roque, Peñablanca (117)	Aggugaddan, Peñablanca (1) Baliuag, Peñablanca (4) Bugatay, Peñablanca (5) Buyun, Peñablanca (3) Cabasan, Peñablanca (2) Mangga, Peñablanca (7) Minanga, Peñablanca (5) Nabbabalayan, Peñablanca (1) San Roque, Peñablanca (4) Sisim, Peñablanca (2) Tuguegaro (1) No answer (7)
Male:Female Ratio	1.3:1	2:1
Age	Min: 18 ≤30: 17% Max: 84 31-50: 49% Ave: 44.78 ≥51: 34%	Min: 22 ≤30: 5% Max: 66 31-50: 56% Ave:46.78 ≥51: 39%
Farming as source of income	Farming as primary source of income: 91.5%, the rest practice farming as secondary source of income or for consumption	Farming as primary source of income: 68.3%, the rest practice farming as secondary source of income or for consumption
Educational attainment	Elementary: 61.83% Highschool: 27% College, Vocational, Graduate Studies: 8.83% No formal education: 2.33%	Elementary: 17.07% Highschool: 43.9% College, Vocational, Graduate Studies: 39.02% No formal education: 0
Ethnicity	Itawes: 69%, the rest are Ibanag, Ilocano, or mixed	
Native/Migrant	Natives of Peñablanca:75%	
Household size	Mean: 4 Max: 14 Min: 1 Mode: 4	
Home ownership	93%	
Farm ownership	89% Average no. of parcels owned: 1.44	

It was intended that the respondents for both surveys are fairly homogenous in terms of basic socio-economic characteristics like age, gender, and educational attainment. All of the respondents practice farming, with majority having farming as a major source of income (91.50% and 68.30% for the adaptation and KAP surveys, respectively) while the rest practice farming for a secondary source of income or subsistence.

To validate the findings from the surveys, several key informant interviews (KIIs) were done with representatives from various stakeholder groups including farmer leaders, the municipal and provincial government, people's organizations (POs), and non-government organizations (NGOs).

RESULTS AND DISCUSSION

Impacts of Coping Strategies, and Adaptation to Extreme Climate Events

The adaptation survey aimed to shed light as to how these farmers respond to the impacts of climate extremes, specifically to typhoons, drought and excessive rains. Almost all of the farmers were able to recall extreme climate events that affected them in the past 20 years, specifically typhoons (98.83%), drought mostly associated with El Niño (94.83%), and excessive rains often associated with La Niña (97.17%). The KIIs with farmers confirm that farmers recognize that extreme events are becoming more severe and are happening more often because of climate change. The most notable events include Typhoons Ketsana (local name Ondoy) in 2009, Imbudo (Harurot) in 2003, and Parma (Pepeng) also in 2009; as well as the 1997 El Niño and the 2010 La Niña. The farmers rated drought as the most severe in terms of negative impacts to their farms and households.

The farmers were also able to identify specific impacts that they experienced from extreme events (**Table 2**). The most notable impacts, across all extreme events, is damage to crops and trees resulting to reduced yield, and reduced farm income. Other livelihood sources were also affected. These results also mirror the previous findings that the farmers perceived drought to be more devastating, as majority were able to cite specific impacts of drought especially to water and soil resources. More farmers were able to mention impacts related to their livelihoods, both farm and non-farm, while a few perceived that extreme events had no impacts in terms of forests and tree plantations, soil resources and water resources. Some farmers also recognized positive impacts including increased yield, increased flowering and faster growing crops due to drought (8%), increased yield and bigger fruits/grains due to excessive rains (6%), faster growing and taller trees because of excessive rains (24%), increased water availability for farm and home use (excessive rains at 24% and typhoons at 18%) and higher income from alternative livelihood including more fish and more wood available and faster drying times for charcoal and fuel wood (drought at 7% and typhoon at 4%).

While the farmers were able to identify specific impacts of extreme events, the opposite could be said of how they respond to these impacts. The most mentioned response across all extreme events is to do nothing or wait because they either cannot do anything or they perceive

Table 2. Top impacts of extreme events observed by smallholder farmers in Peñablanca, Cagayan (n=600, multiple answers).

Typhoons	Drought	Excessive Rains
96.17%. Reduced to no harvest resulting from damaged crops, fallen fruits, flooded farms, destroyed flowers or fruits 72.33% - Reduced farm income due to damaged crops 42.5% - Damaged to trees including destroyed fruits, seedlings and timbre from fallen/ uprooted trees, broken branches, fallen fruits, increased pests and insects 30.17% - Less income from other livelihood (mostly charcoal makers)	83.67%. Reduced to no harvest because crops and fruit trees are damaged or destroyed, smaller or less fruits/flowers, wilted/ dried crops slow growth, fire 71.33% - Water supply (spring, irrigation, river) decline, dry up 53.5% - Reduced farm income due to damaged crops, delayed planting, and reduced working hours due to extreme heat 47.17% - Cracked and fractured soil, cannot plant due to hardened soil, crops dry up due to lack of soil moisture 44.67% - Less to no income from other livelihood because of extreme heat (cannot go to work), damaged alternative sources of income (selling fruits, branches (for fuelwood) are easily broken)	84%. Reduced harvest due to damaged crops from flooding, more weeds, fallen fruits/ flowers, rotting 54% - Reduced farm income due to flooded crops, damaged fruits, etc. 46.83% - Less to no income from other livelihood because of flooding (cannot go to work or sell products), less available wood (for charcoal/ firewood making)

no problem (**Tables 3** to **5**). To do nothing is the most common response for sectors that were identified by farmers as less or not affected by climate extremes, such as forests and tree plantations and soil and water resources. Doing nothing, waiting for better weather and praying for divine intercession are also mentioned by some farmers as a response to climate change impacts on crop yield, farm income, and other livelihood.

Interviews with farmers in Peñablanca revealed that many farmers end up doing nothing because they do not know how to respond to these impacts or they feel that nothing can be done. For instance, the most common response to crop damage and decreased yield due to climate extremes is to simply plant again, without changing crops or farming practices, or to halt planting altogether. *Burke and Lobell* (*2010*) suggested two factors that impede farmers' ability cope with climate change. First was their ability to perceive the change that would warrant action. This is a big challenge especially for smallholders who rely on traditional methods of climate forecasting and would have limited information on long-term climate shifts, as opposed to natural variability. Second was the natural bias of humans towards old ways as opposed to adopting new ones. Many farmers tend to continue practices that have worked in the past, and may miscalculate the need to change farming methods under a new climate.

On the other hand, famers who recognized the need to cope with the impacts of extreme events tend to move away from farming altogether and look for other income sources. In terms of actual response to the top impact of reduced farm income, majority of the farmers looked for another source of income (28 % for typhoon, 43% for drought). Looking for other work was also how some farmers respond to crop failure due to extreme events (11% for typhoons, 27% for drought, 12% for heavy rains). Other work opportunities were often off-farm or as hired laborers in construction projects.

A study on the perception of smallholder farmers in South Africa towards changes in rainfall patterns by *Simelton et al.* (*2013*) reflected similar results. As a response to variable rainfall, some farmers decided to halt planting or to search for other income sources. Poor farmers, in Botswana particularly, claimed to stop planting when the onset of rainy season is erratic because they believe the effort and capital is not worth the expected outcome or profit.

Table 3. Smallholder farmer's coping strategies and adaptation practices to typhoons (n=600, multiple answers).

	Practice	%
Crop yield, agriculture. fruit trees	1. Plant and use trees fuelwood, charcoal and timber for furniture (from fallen trees/branches), feed fallen fruits to livestock	24.33
	2. Plant again, repeat cultivation	20.33
	3. Do nothing (wait, pray, rest)	12.17
	4. Look for an alternative income source (off-farm work, hired labor, selling livestock/farm animals)	11.17
	5. Harvest early or harvest what's left	10.17
	6. Improve farm practice: change to climate resilient crops/varieties, diversification, installing make-shift support for trees/crops	9.00
Forests and tree plantations	1. Do nothing	28.83
	2. Plant and use trees for charcoal, fuelwood, and timber (fallen trees and branches)	28.50
	3. Install support for trees and embankments	9.00
	4. Fix the farm afterwards	1.17
Farm income	1. Look for an alternative income source (off-farm work, hired labor, fishing)	28.33
	2. Sell firewood, fruits, charcoal or furniture from timbre from trees, esp. fallen trees and branches	16.00
	3. Get a loan or borrow money	14.33
	4. Do nothing, wait for good weather	12.67
	5. Plant again after the typhoon	7.67
Other livelihood/ sources of income	1. Do nothing (Cannot do anything, wait, no problem)	25.67
	2. Sell fuelwood, charcoal, timbre from trees	15.50
	3. Look for an alternative income source (off-farm work, hired labor,)	9.83
	4. Work in someone else's farm	6.83
Soil resources	1. Do nothing (cannot do anything, wait, no problem)	44.67
	2. Plant trees/ do not cut trees to prevent erosion/landslides	12.44
	3. Improve farm practice to prevent erosion (contour farming, installing ripraps, change to drought resistant crops)	4.84
Water resources (spring, river)/ irrigation	1. Do nothing (cannot do anything, wait, no problem)	44.83
	2. Use/collect from a new water source for irrigation and consumption (river, well)	8.83
	3. Plant trees/ do not cut trees to retain more water	3.67

Table 4. Smallholder farmer's coping strategies and adaptation practices to drought (n=600, multiple answers).

	Practice	%
Crop yield, agriculture. fruit trees	1. Halt/delay planting, look for another income source (off-farm work, hired labor)	26.83
	2. Do nothing (wait, pray, rest)	18.33
	3. Plant again, repeat cultivation	17.33
	4. Plant and use trees for consumption and/or selling fruits, fuelwood, charcoal and timbre.	8.50
	5. Improve farm practice: change to drought resilient crops/varieties, diversification, applying fertilizers/pesticides/weeding	4.00
Forests and tree plantations	1. Do nothing (wait until the weather improves, pray)	39.17
	2. Plant and use trees for fuelwood, fruits and timbre (for own use and for selling)	10.33
	3. Plant again, cultivate	9.17
	4. Use more water for irrigation/watering the crops	4.17
Farm income	1. Look for another source of income (off-farm work, hired labor)	42.50
	2. Loan/borrow money or use savings	12.50
	3. Do nothing (wait, rest)	11.00
	4. Sell fruits, fuelwood, charcoal and timbre from trees	6.50
Other livelihood/ sources of income	1. Work in someone else's farm	24.33
	2. Do nothing (wait, rest)	17.00
	3. Use trees as shade while working	4.67
Soil resources	1. Do nothing (cannot do anything, wait for rainfall, no problem)	57.34
	2. Continue planting	2.67
Water resources (spring, river)/ irrigation	1. Do nothing (cannot do anything, wait, no problem)	28.17
	2. Plant trees/ do not cut trees to retain more water, avoid flooding and erosion	17.33
	3. Use/collect from a new water source for irrigation and consumption (river, well, machine pumps)	15.17
	4. Conserve water	9.17

Table 5. Smallholder farmer's coping strategies and adaptation practices to intense rains (n=600, multiple answers).

	Practice	%
Crop yield, agriculture. fruit trees	1. Plant again, repeat cultivation	24.50
	2. Plant and use trees for consumption and/or selling fruits, fuelwood, charcoal and timbre (from fallen trees and branches).	17.00
	3. Do nothing (wait, pray, rest)	13.00
	4. Look for an alternative income source (off-farm work, hired labor)	11.80
	5. Build canals and embankments, control the water supply	4.67
Forests and tree plantations	1. Do nothing, cannot do anything	52.33
	2. Consume or sell fruits, fuelwood, and timbre from trees	5.00
	3. Take care of remaining crops, fertilize	3.17
Farm income	1. Do nothing (Rest, wait for good weather)	12.17
	2. Plant again when the weather permits	12.44
	3. Sell fuelwood, charcoal, and timbre (furniture making)	8.17
	4. Loan/borrow money or use savings	6.83
Other livelihood/ sources of income	1. Do nothing (wait, rest)	23.00
	2. Plant again	12.50
	3. Look for an alternative income source (off-farm work, hired labor)	7.50
	4. Work in someone else's farm	6.83
Soil resources	1. Do nothing (cannot do anything, wait, no problem)	40.33
	2. Plant trees/ do not cut trees to prevent erosion/landslides	18.67
	3. Improve farm practice to prevent erosion (contour farming, installing ripraps, change to drought resistant crops)	3.50
Water resources (spring, river)/ irrigation	1. Do nothing (cannot do anything, wait, no problem)	25.50
	2. Irrigation management (close/regulate irrigation, clean the irrigation system)	8.67
	3. Use/collect from a new water source for irrigation and consumption (river, well, machine pumps)	8.17
	4. Conserve water	5.67
	5. Plant trees/ do not cut trees to retain more water, avoid flooding and erosion	5.33

The authors attribute this decision to confounded perception of rainfall changes that may not correspond to the scientifically observed meteorological changes. The paper also suggests that agreement between scientists and farmers as to what is changing and how, impacts the farmers' capacity to adapt (*Simelton et al, 2013*).

Roles of Trees during Climate Extremes

The coping strategies of farmers also revealed the important roles of trees in climate change adaptation. For instance during or after typhoons, the top response is to use trees for fruits, fuelwood, charcoal or timbre (24%), which they consume or sell to augment income loss from damaged crops. They can also feed the fallen fruits to livestock. Although not the top response, farmers also rely on trees to cope with the impacts of drought (9%) and intense rains (17%) to their crops as well as in other sectors.

Trees also play a role in proactive adaptation where farmers who say they use trees during extreme events also claim to plant or protect trees in preparation of it, as opposed to cutting trees for other uses. In fact, planting or preserving trees in anticipation of climate change impacts is the most common proactive coping mechanism undertaken by farmers across all extreme events (18.92% for typhoons, 20.59% for drought, 27.46% for heavy rains), ahead of improving farm practices and infrastructure-related responses (irrigation, building embankments).

Even though it is practiced by a small percentage of the farmers, the way they use trees to cope with climate extremes could also reflect the farmers' knowledge of the ecosystem services provided by trees. The farmers' experiential association towards the goods and services they derive from trees largely determine their knowledge (*Paelmo et al. 2015*). Similar to the study by *Paelmo et al.* (*2015*) and another study on coffee farmers by *Cerdan et al.* (*2012*), the farmers in Peñablanca were able to identify not just the provisioning services mentioned above, but the regulating and supporting services of trees that they benefit from during extreme events. For example, trees help farmers mitigate the impacts of extremes events on their soil and water resources by regulating soil nutrients and soil erosion, and conserving water. Trees also shelter their crops from the wind during the typhoons and from direct sunlight during very hot days, and help make the micro climate more suitable for farming, especially during the summer season. Several farmers also correlate the cutting of trees to the increased flooding and landslide incidents in their area, and claim that they plant trees and avoid cutting them for this reason.

Farmers' Knowledge and Attitudes towards Climate Change

To understand the farmers' motivations for practicing these coping responses or the lack of it, a follow up survey focusing on knowledge and attitude was done. This is in line with the "knowledge-practice-belief" complex as proposed by *Berkes* (1*999 as cited by Paelmo et al. 2015*), where local knowledge and experience are major factors in determining existing practice. The survey was done on a subset of 42 farmers and farmer leaders. It elicited information on the farmers' knowledge and perceptions of climate change and trees/agroforestry, and further explored their adaptation practices.

Similar to a 2013 national survey that said 8 out of 10 Filipinos have personally experienced climate change (*The World Bank 2013*), about 7 out of 10 (67%) farmer respondents in Peñablanca claimed that they were directly affected and cited climate change impacts to their farms. Even fewer (43%) cited specific impacts of climate change on their households and community. Out of the 25 respondents who identified impacts on their farming, 80% mentioned how their crops were damaged or destroyed, leading to decreased yields. Similar with the previous survey, this shows how the most noticeable impacts of CC are on crop yield and therefore, income. Other noticeable impacts are decreasing water supply, death or diseases in farm animals, changes in planting season and increased difficulty in working due to weather.

The respondents' perceptions on their levels of knowledge on climate change varied, but are generally between average and low (62%). Similarly, the respondents' quiz scores which represent knowledge on basic concepts on climate change also varied, where a majority (60%) of the farmers have average level of knowledge, 31% had high level while a few (7%) had low. Varying results were also found by *Ngilangil et al.* (*2013*) in their study of farmers' awareness and knowledge of climate change in Northern Luzon, Philippines. The authors argued that the variations in the famers' level of awareness may be attributed to differences in geographical location, resources, and their exposure to climate change programs.

While farmers are well aware of the impacts and to some extent the causes of climate change, they are still easily confused with the more scientific facts about climate change (**Table 6**). For instance, a large number of respondents answered that reducing greenhouse gases in the atmosphere leads to climate change (85%), when in fact climate change is caused by the increase of greenhouse gases (*IPCC 2014*). A large majority of the respondents

Table 6. Statements and answers on quiz on climate change (n=41).

Statement on Climate Change	True	False	No answer	% Correct	% Wrong
1. Climate change causes extreme events like strong typhoons, droughts, and heavy rains	38	2	1	92.68	7.32
2. Climate change is a global event	41	0	0	100	
3. A warmer earth also causes sea level rise*	16	24	1	39.02	60.98
4. Cutting of trees is one solution to climate change	11	29	1	70.73	29.27
5. Avoiding the use of fossil fuels such as diesel, gasoline and others can reduce greenhouse gasses that cause climate change	30	8	3	70.73	29.27
6. Reducing greenhouse gasses in the atmosphere leads to climate change*	32	6	3	14.63	85.37
7. Methane emission from livestock farming increases greenhouse gas levels*	9	21	11	21.95	78.05
8. There are ways to adapt or mitigate the negative effects of climate change	39	0	2	95.12	4.88
9. Deforestation can help reduce greenhouse gas levels and is a way to adapt to climate change	6	33	2	80.49	19.51
10. Farmers are among the most affected by climate change	38	1	2	92.68	7.32

*: With high number of incorrect responses.

(78%) also incorrectly answered that methane emitted from livestock farming does not increase greenhouse gas levels. Around half of the respondents indicated that higher temperatures did not cause sea level rise. To some extent, these results suggest that scientific information on climate change may not be easily processed by farmers, especially when information is not packaged in a way that is relevant or useful to them (*Prokopy et al. 2015*).

It is good to note that the farmers are in agreement with scientists that climate change is a global event (100%) that causes extreme events (93%) and that there are ways to adapt to its negative impacts (95%).

To quantitatively determine the respondents' attitude toward climate change and adaptation, a 5-scale Likert-type test was used. These negative statements and the Likert scores given by the respondents were then transformed into positive statements to compute for the overall attitude of farmers. Farmers have a fairly positive attitude towards climate change with an average score of 3.83 (1-negative, 3-neutral, 5-positive attitude), with 100% of respondents having a score that is greater than three.

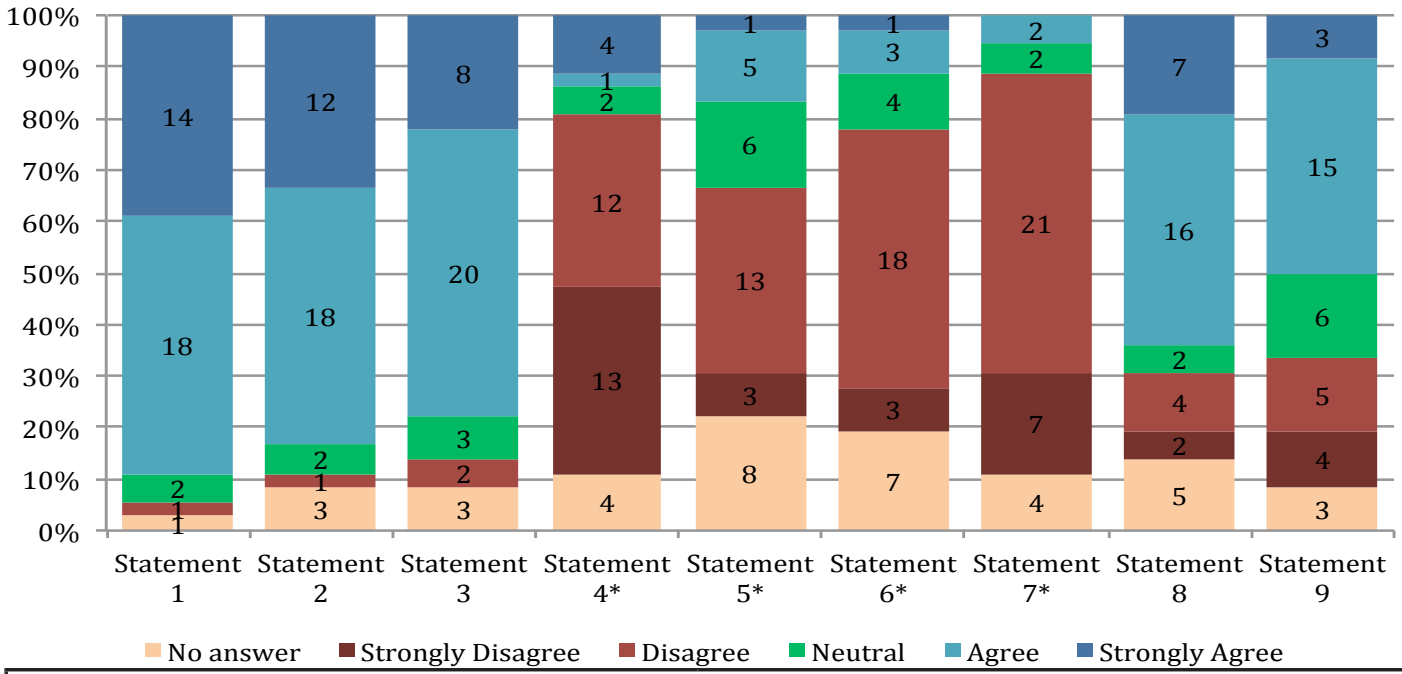
The summary of responses to the individual statements, and revealed that majority of the respondents do agree with statements relating to adaptation, including the statement that say they can adapt to climate extremes (**Figure 1**). However, when asked if they are presently coping or preparing for the impacts of climate extremes, only 26% said yes. Similar to the adaptation survey, even fewer respondents cited specific coping or adaptation strategies when asked how. These seem to contradict the widely accepted notion that attitudes can effectively predict behavior (*Ajzen 1991; Dietz et al. 2005 as cited by Arbuckle et al. 2013*).

Despite their knowledge and positive attitude towards adaptation and believing that they can cope with the negative impacts of extreme events, most farmers still fail to practice coping strategies. This gap can be easily explained by the farmers themselves. In the same survey all of the farmers who said they cannot adapt claimed that they do not know how to or they do not have enough resources to do so. This also mirrors the findings of *Ngilangil et al.* (*2013*) where farmers' adaptation is limited by the lack of resources such as capital, labor, skills, and information. *Pulhin et al.* (*under review*) further confirm that limited adaptation options, high cost, and difficulty of implementation act as barriers to adaptation among farmers. The case of the farmers in Peñablanca is therefore evidence that knowledge and positive attitudes do not always translate to practice of adaptation mechanisms.

The KAP survey also confirmed the results of the previous survey regarding the roles of trees in adaptation to climate extremes, wherein tree-related coping mechanisms were the most common response. The farmers claim that they avoid cutting and even plant trees, especially fruit trees, to cope with the impacts of typhoons, drought, and intense rain. This only highlights the great potential of having trees on or around farms as a multi-benefit adaptation strategy for farmers.

Farmers' Knowledge, Attitude and Practice of Agroforestry

In light of the strong evidence that trees do help farmers cope with the impacts of climate extremes, this study further explored the potential of trees and



Statements	
1. There is climate change	6. There is no solution to the problem of climate change*
2. Humans activities contribute to climate change	7. It is the government's job to prepare for climate change*
3. I can do something to respond to climate change	8. Climate change affects me
4. Climate change is not real*	9. I can adapt to the impacts of climate change like strong typhoons, El Niño, at La Niña
5. I do not contribute to climate change*	

*negative statements

Figure 1. Summary of attitude responses towards climate change and adaptation.

agroforestry as a climate change adaptation strategy for farmers. The following sections discuss the knowledge and attitude of farmers towards agroforestry and how it affects their adoption and practice of agroforestry. Some gaps or limitations that hinder the wider practice of agroforestry in rural Philippines were also identified.

In both the adaptation and the KAP survey, over 80% of the respondents claimed that they practice agroforestry in their farms. However, in the KAP survey only 26% said that they have sufficient knowledge of agroforestry. A large proportion of the respondents did not provide an answer (38%), while 24% perceived that they have very little knowledge or have only heard of agroforestry. The farmers' perceived level of knowledge may also be limiting on how they are able to apply agroforestry in their farms, which is further supported by their description of how they practice agroforestry.

Despite having a low perception of their knowledge level on agroforestry, the quiz scores revealed a higher knowledge level among farmers with an average score of eight correct answers (out of 10 questions). The scores of the respondents on the quiz show 67% of the farmers have high level of knowledge of agroforestry. Meanwhile, those who had average level of knowledge (quiz scores from 5 to 7) made up 17% of the respondents, and 10% had low levels (quiz scores 4 and below). While majority of the farmers seem to have a good grasp of the benefits they can get from agroforestry, some seem to be confused as to where and how agroforestry can be done (**Table 7**). Majority of the statements which relate to agroforestry benefits had very high number of correct answers (more than 85%). These included providing additional income, ecological benefits such as fertilization and soil erosion, as well as climate change adaptation and mitigation. On the other hand, questions that had relatively high numbers of incorrect answers were those regarding the extent of practice of agroforestry.

Out of 39 respondents who answered the agroforestry quiz, 46% incorrectly answered Statement 2 ("Agroforestry can only be done in the forests or mountains"). This is parallel to *Visco et al.'s* (*2011*) results that the misconception about where agroforestry can be applied hinders its widespread practice in the country. Agroforestry could be done in both upland and lowland areas or even within protected areas as long as they are denuded.

Table 7. Statements and answers to the quiz on agroforestry (n=39).

Statement on agroforestry	True	False	No answer	% Correct	% Wrong
1. Agroforestry is only planting trees in the backyard*	15	24	0	61.54	38.46
2. Agroforestry is done only in the forest or mountains*	17	21	1	53.85	46.15
3. Planting trees on farms helps in fertilizing the soil	35	4	0	89.74	10.26
4. Only fruit trees can be planted in farms*	13	26	0	66.67	33.33
5. Having trees can provide an additional source of income	38	1	0	97.44	2.56
6. Agroforestry is not associated with climate change	1	37	1	94.87	5.13
7. Having trees on farms or backyards is one way to adapt to climate change	33	2	4	84.62	15.38
8. Agroforestry is one way of mitigating the cause of climate change	35	1	3	89.74	10.26
9. Landslides or soil erosion get worse because of agroforestry	1	35	3	89.74	10.26
10. Trees on farms do not affect main crops like corn, rice, or vegetables.	6	30	3	76.92	23.08

*: With relatively high number of incorrect responses.

Similarly, 38% incorrectly indicated that agroforestry is constricted to planting trees in the backyard. While agroforestry in home gardens is also a common practice, agroforestry pertains to having woody perennials deliberately placed on the same land unit as agricultural crops or animals (*Lundgren and Raintree 1982 as cited by Nair 1993*), which include main farm plots and not just backyards. Fewer farmers got the fourth statement about planting only fruit trees in farms incorrectly (33%), which also reflects the limited knowledge on the different types of agroforestry systems available that utilizes not just fruit trees but also forest or timbre tree species, and even industrial tree species such as rubber.

This limited knowledge of agroforestry extends to the relationship of trees and annual crops in agroforestry systems. The fourth statement, which was meant to test the farmers' knowledge of the tree-crop interaction aspect of agroforestry, was the fourth statement with the most number of incorrect response (23%).

These misconceptions about agroforestry could have stemmed from the lack of information on agroforestry systems that are more complex than having 'trees on farms' and those that include a "deliberate mixture or sequence of trees and crops". Interviews with Peñablanca farmers revealed that past reforestation and conservation programs in Peñablanca distributed tree seedlings to farmer beneficiaries, often mango or cacao, as part of their agroforestry component. The farmers would then plant these in or around their farms or even backyards, and refer to it as agroforestry farms (**Figure 2**). Projects such as these successfully introduced farmers to the basics and benefits of agroforestry, but gave limited information on the different agroforestry systems that farmers can adopt, aside from using trees as perimeter fencing or getting additional economic benefits from fruit trees.

Although farmers know the tree-planting aspect of agroforestry, they are less knowledgeable about the various agroforestry systems that they can practice. Based on the KIIs, it appears that this was mostly due to their lack of exposure to these systems more than anything else. For example, while lowland agroforestry is a widely researched topic, past reforestation programs introduced agroforestry only to upland farmers and left farmers in Peñablanca thinking that agroforestry could only be done in the uplands. Some farmers also believed that only fruit trees can be planted, most likely because past agroforestry programs only provided fruit trees without explaining that other tree species can be combined with the crops.

Figure 2. A typical agroforestry farm in Baliuag, Peñablanca is planted with corn as the main cash crop interspersed with mango trees and banana.

The attitude of smallholder farmers toward agroforestry was also tested using the Likert scale. The farmers generally have a very positive attitude towards agroforestry, with an average attitude level of 4. The farmers' appreciate the importance of trees in farming and adapting to climate change. Majority of the farmers also disagree that agroforestry is for rich farmers only and it is

hard to do, which showed that they believe that agroforestry can be done by smallholder farmers (**Figure 3**). Almost all were also keen to practice agroforestry. The farmers' positive attitude towards agroforestry is very encouraging as attitude and perception are essential factors to the adoption of such technology (*Visco et al. 2011*).

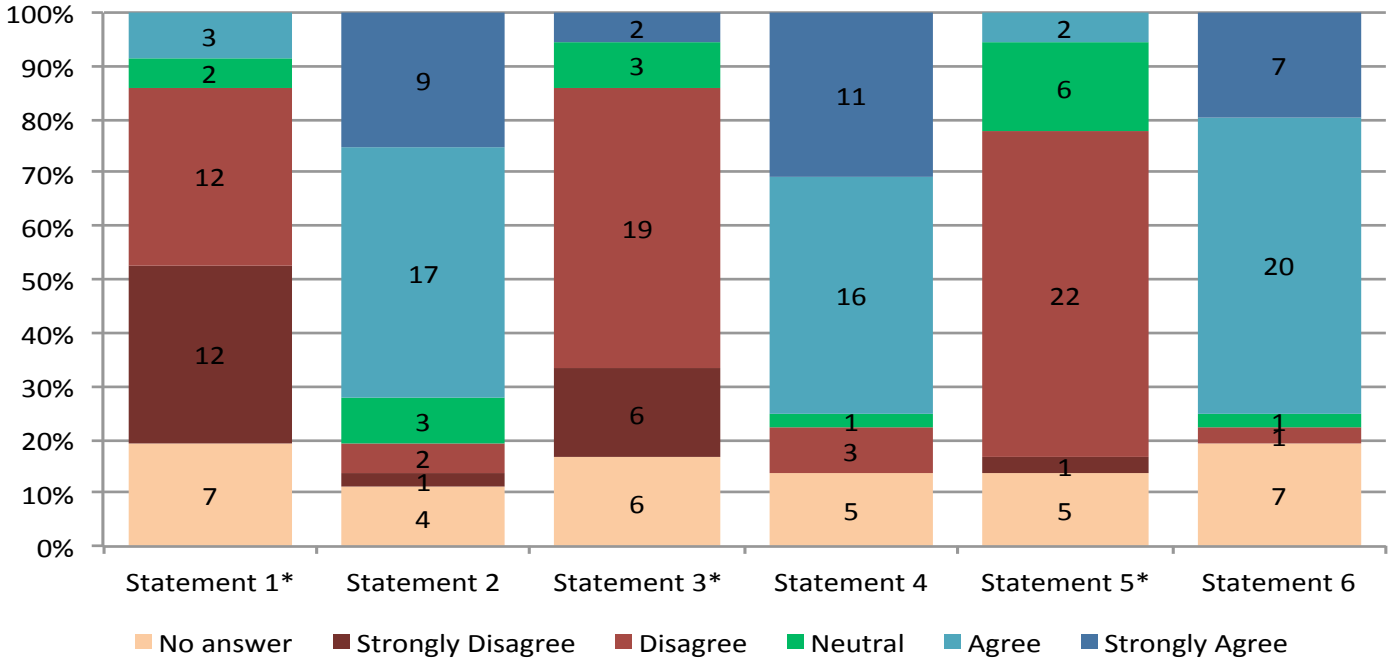
In this case, the positive attitudes towards agroforestry seem to translate to a high level of adoption among farmers. Out of the 42 respondents, 34 (81%) indicated that they practice agroforestry in their farms. Those that do not practice agroforestry stated lack of knowledge and laziness as their reasons. Meanwhile, almost all (98%) of the respondents plant trees in their farms and backyards, including those who claimed they do not practice agroforestry.

The quiz results showing limited knowledge of agroforestry practices are supported by their answers to their agroforestry practices. Majority of the responses focused on planting trees (65%), mostly fruit-bearing but also forest species, in farms and vacant farm or house lots. This may be correct as far as the most basic definition of agroforestry is concerned. Trees interspersed with crops can provide additional and diversified income sources and other significant benefits in terms of ecological diversity, improved soil condition, and reduced erosion (*Parthasarathy and Schubert 2013*). However this limited practice of agroforestry, wherein the farmers haphazardly planted the trees within or around their farms, gives little regard to the requirements of agroforestry systems as proposed by *Nair* (*1993*) that is widely accepted as the scientific definition of agroforestry: the need for a deliberate sequence or pattern among trees and agricultural crops that maximizes its ecological and economic interaction.

Therefore the need for more information on agroforestry that promotes practice, rather than awareness. *Baynes et al.* (*2011*) suggested that dissemination of information that address practical concerns such as harvest security is key to increasing adoption of agroforestry in the Philippines, since it could improve farmers' perception, which the main constraint to agroforestry adoption.

Looking closely at the farmers' own definition of agroforestry in terms of what was planted, only three mentioned intercropping of trees (mango, cacao) with their annual crops (corn, root crops, vegetables). For the rest of the respondents, the choice of agroforestry tree species again reflected the influence of past agroforestry projects in the municipality, as some of the respondents mentioned planting mango, cacao and coffee, which was given for free by the Toyota and CI reforestation project.

The farmers were then asked why they practice



Statements	
1. Trees are not important for me*	4. Agroforestry can help farmers, especially smallholders
2. Trees help me adapt to climate change	5. It is very hard to practice agroforestry in my farm*
3. Agroforestry is for rich farmers only*	6. I want to practice agroforestry

*negative statements

Figure 3. Summary of attitude responses towards agroforestry.

agroforestry. Fifteen out of 34 respondents who gave reasons for practicing it said that agroforestry provided them alternative sources of income (44%) and sources of food (26%). Other reasons pointed to how trees on farms provided regulating services, such as prevention of landslides and flooding (15%) and improvement of microclimate (9%). It is good to note that the farmers do appreciate the provisioning and regulating services provided by agroforestry and trees in general. The reasons stated were also those that could help in climate change adaptation, as some farmers mentioned these provisioning services become more significant when their main crops fail due to drought or typhoons. The farmers' appreciation of role of trees in preventing direct impacts of climate extremes, such as landslides, flooding and extreme heat/drought, was also apparent.

CONCLUSION AND RECOMMENDATIONS

Agriculture and farmers, especially smallholders, are largely dependent on the climate for their livelihoods. Agroforestry, the planting of trees on farms, is one way for farmers to cope with the impacts of climate change, as the trees provide additional sources of income, sources of food, and also ecological services such as prevention of floods and improvement of the microclimate. Although the benefits of agroforestry are numerous, it is still not widely practiced. Many factors contributed to this, including the knowledge levels and attitudes of farmers towards the practice. It is therefore important to understand the knowledge and attitudes of farmers towards climate change, trees and agroforestry, and how these relate to their climate change adaptation practices, especially the use of trees on their farms.

These farmers recognize the extreme climate events that they experience, such as typhoons, drought and intense rains are due to climate change. In addition, they are aware of climate change, and recognize its impacts. This shows that the farmers in Peñablanca are knowledgeable about climate change to some extent, but seem to be in confusion as to the more technical or scientific aspects of climate change. Therefore, further scientific information directed towards farmers must be packaged in a way that is relatable and useful to them.

Another finding is that knowledge and positive attitudes towards climate change and adaptation do not necessarily translate to actual practices of climate change adaptation. Most farmers are not proactively responding to climate change, and even do nothing. Instead they are employing coping mechanisms to react to the impacts of climate change. There is thus a need to focus information, education and communication efforts on adaptation options for farmers. In addition, lack of knowledge is just one barrier to successful adaptation of farmers. Access to resources is a major hindrance for those who want to adapt to climate change. Thus, low-cost and easy practices of adaptation should be promoted to farmers. They need to understand that they have other options, aside from changing livelihoods.

With regards to agroforestry, farmers understand the importance of trees to their livelihoods. Planting and using trees was a part of their farming practices and adaptation strategies. Some form of agroforestry is already practiced in Peñablanca, however it is only limited to planting fruit trees like mango and cacao around the farms.

Insufficient or incorrect knowledge and misconceptions hinder the wider practice of different tried and tested agroforestry systems among farmers. One positive result is that although the concept of agroforestry is complex, farmers are still keen to learn about it. Scientists and extension workers therefore need to encourage farmers to practice agroforestry as a way to adapt to (and mitigate) climate change. There is a need to facilitate a deeper understanding of agroforestry, how it may be practiced and how it may benefit the farmers. It is time to communicate not only about agroforestry in general, but also the specifics of it.

For instance, a larger scale capacity building program on agroforestry can be developed as a strategy for climate change adaptation and mitigation in the country, as opposed to implementing sporadic projects and programs by different organizations. Such a program could include not only information sessions but also field visits or farmer field schools that would allow farmers to see first hand the different agroforestry systems in place. It would require larger investment and collaboration among institutions but the expected benefits for smallholder farmers, especially in the face of climate change, could outweigh the efforts needed.

REFERENCES

ADB (Asian Development Bank). 2009. Building climate resilience in the agricultural sector of Asia and the Pacific. Mandaluyong City, Philippines. Available at: http://www.preventionweb.net/files/11486_BuildingClimateResilienceAgricultur.pdf

Arbuckle J.G. Jr., Mortin L.W. & J. Hobbs. 2013. Farmer Beliefs and Concerns About Climate Change and Attitudes Toward Adaptation and Mitigation: Evidence From Iowa. *Climatic Change* 118 (3). Pp 552-563.

Baccay, O. 2012. The Cagayan valley shield. Philippine Information Agency. Retrieved April 28, 2014 from http://r02.pia.gov.ph/index.php?article=461351488975

Baynes, J., Herbohn, J., Russell, I. & Smith, C. 2011. Bringing

agroforestry technology to farmers in the Philippines: Identifying constraints to the success of extension activities using systems modelling. Small-scale Forestry 10(3):357-376.

Bennagen, E.C., Arcenas, A., Amponin, J. A., Cruz, J.D.D. and Hess, S. M. 2007. An asset-based profile of poor upstream watershed service providers in the Peñablanca Protected Landscape and Seascape. PREM report. Philippines

Bertomeu, M. 2006. Financial Evaluation of Smallholder Timber-based Agroforestry Systems in Claveria, Northern Mindanao, the Philippines. Small-scale Forest Economics, Management and Policy 5(1):57-82.

Bertomeu, M. 2012. Growth and yield of maize and timber trees in smallholder agroforestry systems in Claveria, northern Mindanao, Philippines. Agroforestry Systems 84(1):73-87.

Burke, M. & D. Lobell. 2010. Food Security and Adaptation to Climate Change: What Do We Know? In Climate Change and Food Security. (eds. D. Lobell and M. Burke). Advances in Global Change Research 37, Springer Science+Business Media.

CARICOM (Caribbean Community Climate Change Centre). 2006. Knowledge, Attitude, and Practice KAP Studies on Climate Change in The Caribbean: A Summary Of Findings. Belmopan, Belize.

Cerdan, C.R., M.C. Rebolledo, G. Soto, B. Rapidel, F.L. Sinclair. 2012. Local Knowledge of Impacts of Tree Cover on Ecosystem Services in Smallholder Coffee Production Systems. Agricultural Systems 110. pp. 119-130. doi:10.1016/j.agsy.2012.03.014.

Conservation International. 2014. Peñablanca Protected Landscape and Seascape: Profile. Available at http://www.conservation.org/global/philippines/where/sierra_madre/penablanca /Pages/penablancaprofile1.aspx

Dioula, B. M., Deret, H., Morel, J., Vachat, E. d., & Kiaya, V. 2013. Enhancing the role of smallholder farmers in achieving sustainable food and nutrition security. Food and Agriculture Organization of the United Nations (FAO).

Easterling, W.E., P.K. Aggarwal, P. Batima, K.M. Brander, L. Erda, S.M. Howden, A. Kirilenko, J. Morton, J.-F. Soussana, J. Schmidhuber and F.N. Tubiello. 2007. Food, Fibre and Forest Products. Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. (eds. M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson). Cambridge University Press, Cambridge, UK, 273-313.

IPCC (Intergovernmental Panel on Climate Change). 2012a. Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation. A Special Report of Working Groups I and II of the Intergovernmental Panelon Climate Change. (eds. C. Field, V. Barros, T. Stocker, D. Qin, D. Dokken, K. Ebi, et al.). Cambridge University Press, Cambridge, UK, and New York, NY, USA.

IPCC. 2014: Summary for policymakers. In: Climate Change 2014: Impacts ,Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (eds. C.B. Field, V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L.White). Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 1-32.

Lasco, R. D., Delfino, R. J. P., Catacutan, D. C., Simelton, E. S., & Wilson, D. M. 2014a. Climate Risk Adaptation by Smallholder Farmers: The Roles of Trees and Agroforestry. Current Opinion in Environmental Sustainability, 61, 83–88. doi:10.1016/j.cosust.2013.11.013

Lasco, R. D., Delfino, R. J. P., & Espaldon, M. L. O. 2014b. Agroforestry Systems: Helping Smallholders Adapt to Climate Risks While Mitigating Climate Change. Wiley Interdisciplinary Reviews: Climate Change, 56, 825–833. doi:10.1002/wcc.301

Magcale-Macandog, D. B., Rañola, F.M., Rañola, R.F. Jr., Ani, P.A.B. & Vidal, N.B. 2010. Enhancing the food security of upland farming households through agroforestry in Claveria, Misamis Oriental, Philippines. *Agroforestry Systems* 79(3):327-342.

Morton, J.F. 2007. Climate Change and Food Security Special Feature: The Impact of Climate Change on Smallholder and Subsistence Agriculture. Proceedings of the National Academy of Sciences 104: 19680-19685

Municipal Government of Peñablanca, Cagayan. 2009. The Municipal Forest Land Use Plan of Peñablanca, Cagayan, 2010-2015. Cagayan, Philippines.

Nair, P. K. R. 2013. Agroforestry: Trees in Support of Sustainable Agriculture. Encyclopedia of Earth Systems and Environmental Sciences. Elsevier. Available online at: http://dx.doi.org/10.1016/B978-0-12-409548-9.05088-0

Nair, P. K. R. 1993. An Introduction to Agroforestry. Kluwer Academic Publishers. Kluwer, Dordrecht. pp. 499.

Ngilangil L.E., S.O. Olivar & M.L.A. Ballesil. 2013. Farmers' Awareness and Knowledge on Climate Change Adaptation Strategies in Northern Luzon Philippines. *International Scientific Research Journal* 5 (3). ISSN 2094-1749.

NSO (National Statistic Office). 2012. 2010 Census of Population and Housing: Cagayan Valley. Available at http://web0.psa.gov.ph/sites/default/files/attachments/hsd/pressrelease/Cagayan%20Valley.pdf

Paelmo R.F., Visco R.G., Landicho L.D., Cabahug R.D., Baliton R.S., Espaldon M.L. and Lasco R.D. 2015. Analysis Of The Farmers' Knowledge on The Ecosystem Services of Trees in the Molawin-Dampalit Watershed, Makiling Forest Reserve, Philippines. *Asia Life Sciences* 24 (1) . pp. 169-186.

Parthasarathy D. & C. Schubert. 2013. How growing mangoes can make a difference in a farmer's life. News Blog. CGIAR Research Program on Climate Change, Agriculture, and Food Security CCAFS. Available at http://ccafs.cgiar.org/how-growing-mangoes-can-make-difference-farmers-life#.VT7bACGeDGc.

Pattanyak, S. & Evan Mercer, D. 1998. Valuing soil conservation benefits of agroforestry: contour hedgerows in the Eastern Visayas, Philippines. *Agricultural Economics* 18(1):31-46.

Prokopy, L., Morton, L., Arbuckle, J., Mase, A., & Wilke, A. K. 2015. Agricultural Stakeholder Views on Climate Change: Implications for conducting Research and Outreach. *Bulletin of the American Meteorological Society*, 181-190.

Pulhin, J.M., R.J.J. Peras, F.B. Pulhin & D.T. Gevana. Under Review. Farmers' Adaptation to Climate Variability: Assessment of Effectiveness and Barriers Based on Local Experience. Submitted to the Journal of Environmental Science and Management. Los Banos, Laguna.

Simelton E., Quinn C.H., Batisani N., Dougill A.J., Dyer J.C., Fraser E.D.G., Mkwambisi N., Sallu S., Stringer L.C.. 2013. Is Rainfall Really Changing? Farmers' Perceptions, Meteorological Data, and Policy Implications. Climate and Development. DOI:10.1080/17565529.2012.751893

Smit, B. and M.W. Skinner. 2002. Adaptation Options in Agriculture to Climate Change: A Typology. Mitigation and Adaptation Strategies for Global Change 7: 85–114. Kluwer Academic Publishers, Netherlands.

Snelder, D.J. and R. D. Lasco. 2008. Smallholder Tree Growing in South and Southeast Asia. In Smallholder Tree Growing for Rural Development and Environmental Services: Lessons from Asia. eds. Snelder, D.J. and R. D. Lasco. Advances in Agroforestry. Springer Science + Business Media B.V.

The World Bank. 2013, June 21. Survey: 8 of 10 Filipinos Personally Experience Impacts of Climate Change. Retrieved October 13, 2015, from The World Bank Press Release: http://www.worldbank.org/en/news/press-release/2013/06/20/survey-8-of-10-Filipinos-Personally-Experience-Impacts-of-Climate-Change

Tolentino, L.L., L.D. Landicho, C.C de Luna, & R.D Cabahug. 2010. Case Study: Agroforestry in the Philippines in Routledge Handbook of Climate Change and Society. (eds. C. Lever-Tracy)

Toyota Motor Corporation and Conservation International. 2009. Philippine Peñablanca Sustainable Reforestation Project. Project Design Document for Climate, Community and Biodiversity Standards. 2nd Edition. Available at https://s3.amazonaws.com/CCBA/Projects/Philippines_Penablanca_Sustainable_Reforestation_Projects/CCB-PDD-PPSRP_ver_Dec8.pdf

Vermeulen, S. J., Campbell, B. M., & Ingram, J. S. I. 2012. Climate Change and Food Systems. Annual Review of Environment and Resources, 371, 195–222. doi:10.1146/annurev-environ-020411-130608

Visco, RG, LD Landicho, RD Cabahug, RF Paelmo and CC de Luna. 2011. National Case Study on Agroforestry Policy in the Philippines. Unpublished. University of the Philippines Los Baños-Institute of Agroforestry. College, Laguna, Philippines.

ACKNOWLEDGMENT

This paper was produced as part the research project entitled Adapting to Extreme Events is Southeast Asia through Sustainable Land Management Systems of the World Agroforestry Centre - Philippines, (ICRAF) and is funded by the CGIAR Research Program on Climate Change, Agriculture and Food Security (CRP-CCAFS) from January 2012 to March 2015. The authors would like to thank all those who assisted in the implementation of the project, including colleagues and staff at ICRAF, partners from the University of the Philippines Los Baños, and the people of the Municipality of Peñablanca, Cagayan.