Journal of Rural and Community Development

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Citation:
Peñalba, E. H. (2019). Adaptation to climate change among farmers in Bulacan, Philippines. *The Journal of Rural and Community Development, 14*(2), 1–23.

Publisher:
Rural Development Institute, Brandon University.

Editor:
Dr. Doug Ramsey

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ISSN: 1712-8277 © Journal of Rural and Community Development
www.jrcd.ca

Adaptation to Climate Change among Farmers in Bulacan, Philippines

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Abstract

The vulnerability of the Philippines to climate change and variability has been highlighted by its exposure to severe weather-related conditions. Farmers are particularly vulnerable to such adverse effects given their limited adaptive capacity. In this regard, this study examines the local adaptation experiences and practices of farmers in a second-class farming municipality. It is then based on the assumption that a lay understanding of how farmers perceive and adapt to climate change can be used to provide implications for enhancing their adaptive capacity. Using a combination of qualitative data from key informant interviews and focus group discussion and secondary data from government agencies, this paper reveals that farmers perceive serious health and livelihood risks despite having limited knowledge of how climate change occurs. They recognize that changes in climate conditions have caused considerable effects to temperature and rainfall which, in turn, have posed serious challenge to water supply. Their farming activities are also at risk from interrelated impacts such as damage to crops, pest infestation, and decrease in rice yield. Hence, they consistently employ common adaptation measures as direct responses to climate variability such as the planting of new crop varieties, use of chemical fertilizers and pesticides, use of technology in farming, and diversification of household income. However, the lack of financial resources hinders them from utilizing new adaptation techniques and technologies, which they perceive to be more appropriate and beneficial. These results suggest a more conscious effort of transforming coping strategies to short-term climate variability into adaptation measures to long-term climate changes.

Keywords: climate change; adaptation; farmers; agriculture; Philippines

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1.0 Introduction

The vulnerability of the Philippines to the impacts of global climate change has been well documented. In the Global Climate Risk Index, the country ranked seventh among more than 180 countries which have been affected most by severe weather-related events over the past 20 years (Kreft & Eckstein, 2014). It also placed third in terms of climate change vulnerability, particularly on exposure to natural climate disasters based on the World Risk Index Report of the United Nations University Institute for Environment and Human Security (2012). Climate change projections suggest the likelihood of frequent occurrences of extreme weather conditions. By the years 2020 and 2050, according to the Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA), climatic conditions which are likely to become more frequent include increased hot temperatures, dry season, and

ISSN: 1712-8277

heavy rainfall (Cinco, Hilario, De Guzman, & Ares, 2013). It is projected that the largest temperature increase will be felt during the summer months—March, April, and May—and the largest rainfall increase will be experienced during the northeast monsoon season—December, January, and February.

These changes are expected to affect the agriculture-dependent economy of the country. In particular, potential negative effects can be directly experienced by communities engaged in rice production, "one of the most vulnerable sectors in the agriculture industry to aggregate impact of global warming and climate change" (Philippine Rice Research Institute Department of Agriculture, 2015, p. 21). To prove this point, from 1970 to 1990, the onset of floods, droughts and typhoons led to 82.4% of domestic losses in rice production (Lansigan, De los Santos, & Coladilla, 2000). From 1975 to 2002, the occurrence of an average of 20 tropical typhoons per year led to an annual average damage to agriculture worth 3.047 billion pesos (Greenpeace, 2005, as cited in Stromberg, Esteban, & Gasparatos, 2011). Sheehy, Mitchell, and Ferrer (2006) reported a yield loss of about 6% for every 1°C increase in average temperature in the country for the 1992–2003 period. Prantilla and Laureto (2013) cited that the continuous occurrence of the adverse impacts of climate change, resulting in low agricultural productivity due to water and thermal stresses, is likely to affect millions of Filipino farm households.

Adaptation of the agricultural sector is thus considered an imperative measure to reduce the vulnerability of rural communities to climate change (Bryan et al., 2013; Deressa, Hassan, Ringler, Alemu, & Yesuf, 2009). The Intergovernmental Panel on Climate Change (2007) defined adaptation as the "adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities" (p.6). It includes responses which can be applied to either short-term or long-term changes in climate. In particular, adaptation in agriculture is dependent on regional, sector, and farm-specific conditions (Reidsma, Ewert, Lansink, & Leemans, 2010). Smit and Skinner (2002) listed four main categories of adaptation options which are (a) technological developments, (b) farm production practices, (c) farm financial management, and (d) government programs and insurance. Successful adaptation is manifested when farmers plant crop varieties that are resistant to climate-related stressors (technological developments) or when they transform their farming practices through livelihood diversification and shifts in cropping calendar (farm production practices). They can also make adaptation decisions based on their capabilities to buy crop insurance or diversify their income sources (farm financial management) or through institutional assistance such as government's agricultural subsidy and financial sector's private insurance (farm financial management).

Brugger and Crimmins (2013) contended, however, that the definition of adaptation set forth by IPCC provides a scientific perspective and framing of climate change. Such a definition tends to overlook ordinary people's perceptions and practices related to their adaptation. In the context of agriculture, a shift from technical knowledge to a lay understanding of how farmers perceive and cope with the changing climate conditions is deemed significant and beneficial. Hence, a framing of adaptation based on the experiences of farmers is essential for crafting policies that can improve their adaptive capacity (Bryan, Deressa, Gbetibouo, & Ringler, 2009). This is particularly relevant in clarifying the role of farmers' beliefs on climate change in facilitating decisions to undertake adaptation measures. After all, the crucial issue about whether climate change is caused by human activities or natural environmental changes is still unsettled. For instance, Arbuckle, Morton, and Hobbs (2013) reported the variation in Iowa farmers' perceptions of the root causes of climate change. A majority of the farmers believed that climate change exists while more than a quarter of them were still uncertain of its occurrence.

By exploring how farmers frame climate change, this would allow further understanding of how they are more likely to observe and perceive climate-related changes. It is likely that such observations and perceptions are either consistent or not with the historical climate records (Makuvaro, Walker, Masere, & Dimes, 2018). It is also likely that the changes they perceive are reflective only of the local environmental factors but not of the regional and global changes, or vice-versa (Niles & Mueller, 2016). Furthermore, as suggested by the literature, farmers are most likely to respond to short-term climatic changes by employing strategies that could range from those aimed at addressing immediate risks to actions that would prepare them in preventing long-term risks (Bryan et al., 2013; Feola, Lerner, Jain, Montefrio, & Nicholas, 2015). In this aspect, the integration of local knowledge of climate change adaptation has become a relevant practice among farmers. By closely observing the changing patterns of climate factors and even personally experiencing extreme events, they create distinct perceptions of climate change that serve as their bases for decision making (Dubey, Trivedi, Chand, Mandal, & Rout, 2017; Nguyen et al., 2016).

Also crucial to farmers' decisions is the information that originates from varied sources, which can then be accessed by farmers not only just through government-sponsored information campaigns and extension services but also through agro-dealers and communication media. In their synthesis of empirical studies on African agriculture, Juana, Kahaka, & Okurut (2013) reported that the provision of climate-related information through extension services serves as a significant factor of adaptation. Agro-dealers, radios, televisions, and even mobile phones are becoming alternatives to extension services, which can be utilized by farmers in practicing climate-smart agriculture (Nyasimi, Amwata, Hove, Kinyangi, & Wamukova, 2014). Nhemachena, Hassan, & Chakwizira (2014) also highlighted these sources of information as a mechanism that can be used by government agencies to raise awareness of changes in climate. Demographic characteristics of farmers also influence farmers' responses. Sarker, Alam, and Gow (2012) found that the adaptation decisions of farm households in Bangladesh were dependent on gender, age, farm size, annual income, and household head's education. Gender and years of agricultural experience were identified as significant determinants of the uptake of adaptation strategies among farmers in West Africa; however, household size and years of education did not influence selection of such strategies (Yegbemey, Yabi, Tovignan, Gantoli, & Kokoye, 2013). Prantilla and Laureto (2013) found that age, education, and farm experience of Filipino farmers in Bukidnon significantly affected their adoption of adaptation mechanisms.

Previous studies have acknowledged the importance of understanding farm-level awareness, knowledge, and perceptions, especially of those who are directly affected by climate change. Nkomwa, Joshua, Ngongondo, Monjerezi, & Chipungu (2014) found that traditional beliefs of farmers in Southern Malawi served as their guide in determining the kind of adaptation strategies to be applied to crop selection and planting time. Elum, Modise, and Marr (2017) reported how experience of and awareness to climate change among farmers in South Africa could be translated into undertaking response strategies. Shaffril, Krauss, and Samsuddin (2018) highlighted the importance of engaging in social activities among Asian farmers, allowing them to obtain information and raise awareness about how they could best respond to climate change impacts. In the Philippines, Ngilangin, Olivar, & Ballesil (2013) discovered that the high level of awareness among farmers resulted in the adoption of various strategies except those which they regarded as costly, demanding of time and effort, and highly technical in nature. Accordingly, these studies have offered remarkable insights to climate change literature, policymaking decisions and responses, and local capacity building (Gandure, Walker, & Botha, 2013). Following the definition of Marshall, Park, Howden, Down, and Jakku (2013), climate change awareness refers to “the extent to which primary producers relate to and prioritize climate change as a driver of change” (p. 30). In the context of farming, such a definition translates to the improvement of adaptive capacity with consideration of other driving forces that allow farmers to convert their existing resources to viable adaptation measures.

Moreover, other studies focused on how farmers employ adaptation measures. For instance, a study on adaptation to climate variability in South Africa indicated that farmers could easily identify subtle changes in climate parameters, allowing them to employ specific coping strategies like commercializing livelihood, changing farming practices, and exploiting landscape’s spatial and temporal diversity (Thomas, Twyman, Osbhar, & Hewitson, 2007). Using survey data collected in the Nile basin of Ethiopia, Deressa et al. (2009) showed that household characteristics and increasing temperature affect farmers’ choices in using adaptation methods such as irrigation, soil conservation, alteration of planting dates, and use of better crop varieties. Despite the availability of various adaptation methods, farmers still face constraints in utilizing such methods due to lack of resources, technology, and institutional capacity (Gandure et al., 2013). In their assessment of vulnerability of farming communities in a Philippine municipality using agent-based modeling, Acosta-Michlik and Espaldon (2008) identified the lack of money and information as the foremost constraints in using technical adaptation measures. To address these constraints, according to a concrete initiative implemented to help Brazilian smallholder farmers, the implementation of adaptation strategies should be based on existing vulnerability studies and local experiences and should be combined with development initiatives and adaptive capacity enhancement (Simões et al., 2010).

This study is therefore based on the notion that a lay understanding of farmers’ perceptions of climate change is necessary in understanding how they adapt to the changing climate conditions. In climate change discourse, sustainable adaptation requires the interaction of various determinants of adaptive capacity (Engle, 2011). The decision to use even a particular adaptation measure is largely dependent on determinants like institutional and organizational support, availability of resources, access to information, and availability of social networks. To function effectively as driving factors of adaptive capacity, these determinants must be interdependent of each other taking into account various contexts where they can function in a different way (Smit & Wandel, 2006). Drawing insights from agricultural systems research, Smit and Skinner (2002) claimed that adaptation is influenced by the interaction of the said determinants, decisions made at varying levels, and forces internal or external to the agricultural system. Its success depends on how farmers can empower themselves to mobilize their resources as a preparatory measure in responding to future environmental stresses (Berman, Quinn, & Paavola, 2012). However, these farmers have limited resources and would usually rely on indigenous knowledge to respond to the adverse impacts of climate-related disturbances (Peñalba & Elazegui, 2013). It is in this context that there is a need to examine how their adaptive capacity can be improved even at a micro-level perspective.

The general objectives of this study are to examine the climate change adaptation of farmers in a rural municipality and determine its implications for the improvement of their adaptive capacity. This research has the following specific objectives: (a) to determine the socio-economic profile of the farmers, (b) to understand their awareness and perceptions of climate change, (c) to identify the effects of climate change on rice production based on their perceptions, and (d) to determine the strategies they employ in adapting to climate change.

2.0 Study Context

The study was conducted in May 2014 in Pandi, a second-class farming municipality in the province of Bulacan. The municipality covers an area of 3,120 hectares, of which approximately 2,494 hectares or 80% of the total land area is primarily devoted to the cultivation of rice. Based on the modified Corona classification, the town has Type I climate which is characterized by two pronounced seasons: dry from November to April and wet during the rest of the year.

In particular, the study sites came from four *barangay* or villages namely Cupang, Malibong Bata, Malibong Matanda, and Masagana. Cupang and Masagana are located in the northwestern part of Pandi while Malibong Bata and Malibong Matanda are parts of the southwestern portion of the town. These villages cover an agricultural area of 618 hectares or 25% of the total land area comprising of both irrigated and rain-fed farmlands. They are located in the fertile central plains of Luzon, specifically in a land system consisting of "undulating side slopes and low ridges with small to medium intermediary valleys [and] has fully developed terraced rainfed and irrigated paddies devoted to rice farming" (Bureau of Soils and Water Management, 2011, p. 8). Agricultural areas found in the topographical high locations of Cupang, Malibong Bata, and Malibong Matanda have "a low to moderate susceptibility to flooding [while those found in the low elevation of Masagana have] a moderate to high susceptibility to flooding" (Mines and Geosciences Bureau–Region 3, 2012, pp.13–14).

3.0 Methods

This study utilized a combination of structured questionnaire, semi-structured interview schedule, and focus group discussion (FGD). The instruments were submitted to the scrutiny of three experts composed of university researchers and a leader of a farmers' organization in Bulacan for validation. The first phase of data collection involved 20 key informant interviews, which were conducted in the four predominantly agricultural villages. The interviews were comprised of purposely sampled farmers who own farmland with an area of least one hectare and who have been engaged in supervising their own livelihood for at least five years. The key informants were identified through snowballing, in which case the farmers were asked to identify other possible informants. They were initially asked to answer questionnaires which included information regarding their socio-economic characteristics, perceptions on climate change conditions, and actions they undertake to respond to such conditions through adaptation measures. Afterward, they were involved in face-to-face interviews which obtained further information regarding their experiences with the changing climate conditions.

For the second phase of data collection, an FGD was conducted with another set of participants composed of eight farmers who were all officers and members of a farmers' organization in the municipality. Using an interview schedule, the discussion focused on their experiences on living with and responding to climate change and its impacts to their livelihood. This supplemented the findings and allowed for further exploration of the perceptions that emerged from the key informant interviews.

To provide a comparison between people's perceptions of climate variability and change and actual climatic observations, daily and monthly temperature and rainfall data for the 1980–2013 period were collected from PAGASA Science Garden Station. The data were averaged on a yearly basis. It should be noted that site-specific data for Pandi, Bulacan were not available. Secondary data on rice production in Pandi were collected from the Municipal Agricultural Office. The discussions in both key informant interviews and FGD were digitally recorded for transcription. Data analysis and presentation comprised descriptive results supported by interview responses and scientific data.

4.0 Results

4.1 Socio-economic Characteristics of Respondents

A total of 20 key informants, who were residents of Cupang (n = 5), Malibong Bata (n = 5), Malibong Matanda (n = 5), and Masagana (n = 5), answered the questionnaires and participated in the interviews. As shown in Table 1, almost all (n = 18) of them were males. Seven of them were within the age range of 60 to 69 years. Most (n = 16) of them were married, with six of them living with three to four children in their households. Almost half of them finished elementary (n = 9) and high school (n = 9). In terms of their primary livelihood, four out of 10 key informants had been supervising their farmlands for about 26 to 35 years. Most (n = 17) of them owned farmland with total land areas ranging from 1 to 5 hectares, with almost half of them (n = 9) employing 11 to 20 farm workers on a seasonal, casual, or temporary basis. A large majority (n = 13) of them were able to harvest 100 sacks of rice and below during both dry and wet seasons, and more than half (n = 11) of them earned an annual average income of Php50,000 and below.

Table 1: *Socio-economic Characteristics of Respondents*

Variable	**Frequency**
Place of residence	
Cupang	5
Malibong Bata	5
Malibong Matanda	5
Masagana	5

Table 1 continued	
Age	
70–79	1
60–69	7
50–59	6
40–49	5
30–39	1
Sex	
Male	18
Female	2
Civil status	
Single	3
Married	16
Widower	1
No. of children	
7–8	1
5–6	5
3–4	6
1–2	5
0	3
Educational attainment	
Elementary	9
High School	9
Vocational	1
College	1
Years of experience in rice farm supervision	
46–55	2
36–45	5
26–35	8
16–25	3
5–15	2

Table 1 continued

Area of owned/supervised rice farm (hectare)	
16–20	1
10–15	1
6–10	1
1–5	17
No. of rice farm workers	
31–40	3
21–30	3
11–20	9
1–10	5
No. of sacks of rice produced during wet season	
301 and above	4
201–300	1
101–200	2
100 and below	13
No. of sacks of rice produced during dry season	
301 and above	4
201–300	0
101–200	3
100 and below	13
Annual income from rice production	
200,001 and above	3
150,001–200,000	1
100,001–150,000	2
50,001–100,000	3
50,000 and below	11

4.2 Awareness and Perceptions of Climate Change and Its Impacts

Based on their own experiences and observations, as shown in Table 2, all (n = 20) of the key informants revealed that they were aware of the impacts of climate change. While they were aware of certain climatic anomalies, most of the farmers could not instantly explain why and how climate change occurs. Their knowledge of this phenomenon seemed to be limited only to its perceived effects. Only four key informants were able to draw a link between ozone depletion and climate change. For those who were aware of the causes of climate change, they seemed to follow the 'consensus' view that humans and their activities are the ultimate cause. A farmer from Malibong Bata even blamed industrialized countries for contributing to climate change.

Table 2: *Respondents' Awareness About the Effects of Climate Change*

Variable	**Frequency**
Awareness of the effects of climate change	
Yes	20
No	0
Access to climate change-related information	
Yes	8
No	12
Source of climate change-related information	
Government	5
Non-government organization	0
Company	1
Others (People's organization)	2

Despite this awareness, as also indicated in Table 2, 12 of them still did not receive information on climate change, particularly on its effects. The key informants who had access to such information would usually receive it from the government (n = 5), particularly from the Department of Agriculture and Municipal Agriculture Office (MAO) of Pandi. A farmer from Cupang cited a MAO-sponsored program called Farmer Field School on Palay Check System which provided him basic information on climate change. In Table 3, As regards the effects of climate change, increased temperate was the most commonly observed effect observed over the past years by the key informants. They further revealed in their interview responses that temperature has become extremely high over the years, posing concerns on their health and livelihood.

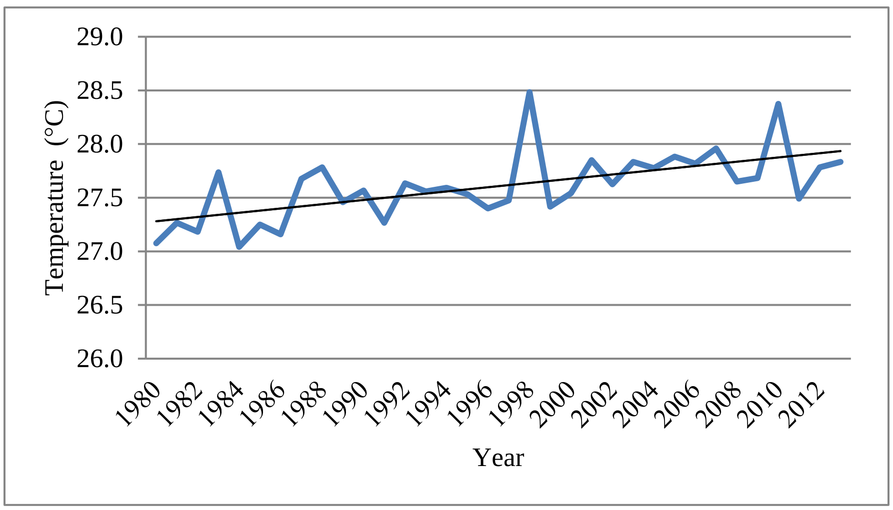
Table 3: *Respondents' Perceptions About the Effects of Climate Change*

	Frequency	**Rank**
Observed effects of climate change		
Increased temperature	17	1
Frequent typhoons	15	2
Frequent droughts or rainfall	14	3

The focus group participants also cited illegal logging and indiscriminate quarrying as contributing factors to climate change. The blame was also given to manufacturing industries for creating uncontrollable pollution. Like the key informants, they observed the increasing level of temperature. Using climatic data provided by PAGASA for Science Garden Station, scientific data on the increasing trend of temperature seemed to agree with the farmers' perceptions (Figure 1). Inter-annual temperature variability indicates an increase in temperature ranges from 0.1°C to 1.0°C in more than half of the years of the 1980–2013 period. However, there is still a need to establish statistical significance to completely validate this observation. PAGASA (2011) projects a seasonal temperature increase of 0.9°C–1.1°C by 2020 and an increase of 1.7°C–2.1°C by 2050 in Bulacan.

Another concern expressed by the focus group participants was the increasing unpredictable weather patterns. They cited past extreme weather events like El Niño, which happened from 1997 to 1998, and Typhoon Ketsana (Ondoy) in 2009. They were able to easily recall these key events that severely caused damage to their farmlands. Their main concern revolved around the frequent occurrences of flash flood, tornado, and typhoon that may severely disrupt their livelihood. They also worried about the persistence of climate change impacts in the next generation.

Figure 1. Annual mean temperature series and trend for Bulacan (1980–2013).

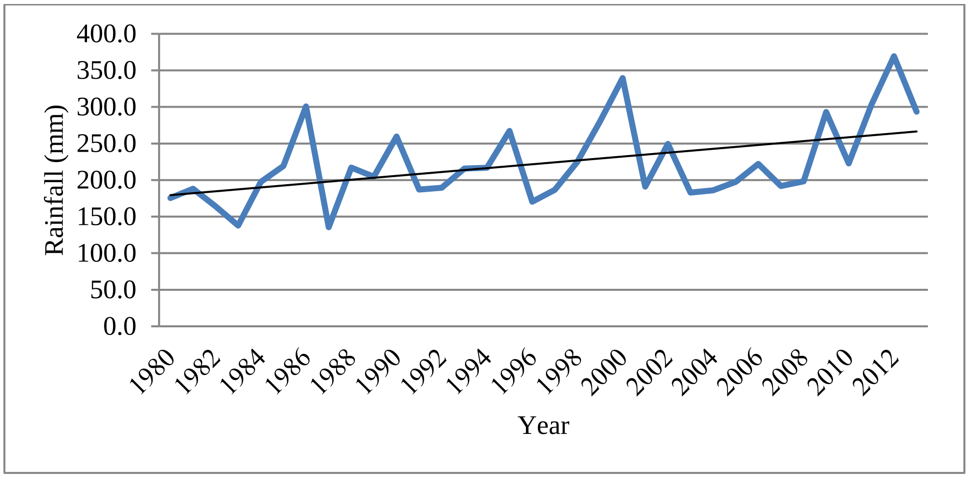


Source: PAGASA Science Garden Station

Moreover, rainfall variability was described by the participants to be unpredictable especially during the dry season. As one member of a farmers' organization put it: "Dry season is already happening, but it is still raining unexpectedly. The weather condition is no longer normal." In general, an increasing trend in rainfall was reported for the 1980–2013 period (see Figure 2). When considering only the values for the dry season, slight increases in rainfall with an average annual rainfall of 57.5 mm were reported (see Figure 3). Above mean annual rainfall was received in almost half of the years, particularly for the past seven years. Moreover, the most recent 2013 monthly data revealed that the rainfall values received in five out of six months were higher than 50 mm. According to the modified Corona classification, a dry month has "less than 50 mm of rainfall, although a month with more than 100 mm can still be considered as dry if it comes after three or more very dry months"

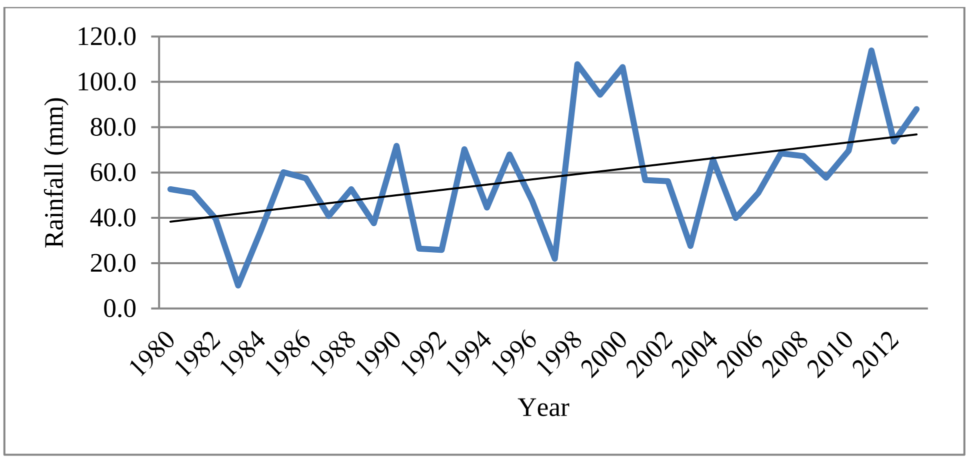
(Monsalud, Montesur, & Abucay, 2003, p. 3). These climatic data confirm the farmers' perceptions of rainfall variability although statistical significance still needs to be established to completely validate such claim.

Figure 2. Annual mean rainfall series and trend for Bulacan (1980–2013).



Source: PAGASA Science Garden Station

Figure 3. Annual mean dry season rainfall series and trend for Bulacan (1980–2013).



Source: PAGASA Science Garden Station

There were also instances when delay in rainfall occurred, forcing the farmers to change their cropping calendar. This was particularly true for focus group participants who solely relied on rain-fed agriculture. Worst, they were not able to cultivate rice due to drought, a condition they associated with the onset of El Niño. This was demonstrated in the climatic data that reveal below-average rainfall in the last quarter of 1997 until the first quarter of 1998. From October 1997 to March 1998, areas affected by El Niño received less than 40% of the normal rainfall (Hilario, De Guzman, Ortega, Hayman, & Alexander, 2009).

4.3 Awareness and Perceptions of Climate Change and Its Impacts on Rice Production

As shown in Table 4, almost all (n = 19) of the key informants were aware that climate change had caused significant negative impacts on their rice production activities. They regarded supply of water (n = 13) as the principal aspect of farming mostly affected by the changing climate conditions (see Table 4). Despite the availability of irrigation systems in the four villages, key informants who practice irrigated agriculture still complained of the expensive service fees and difficulty in sourcing irrigation water for remote farmlands. Funding from government institutions also seemed be a primary concern. For instance, a farmer from Cupang, who had to pay an irrigation charge of Php12,000 proportional to a one-hectare farm area, complained about how government funds were diverted to fake projects. According to him, “the funds intended for agriculture should rightfully be given to us.” However, a Masagana-based farmer, who is an officer of an irrigators’ association, shared how his organization gained financial support from the local government and National Irrigation Administration. Albeit aware of such impacts, as also indicated in Table 4, three quarters (n = 15) of the respondents did not have any access to information about the overall impacts of climate change on rice production. The government (n = 3) still served as the primary source of information on the said impacts for those who had information access.

Specifically, as indicated in Table 5, they cited damage to rice crops caused by the changing weather patterns as the foremost observed effect of climate change (n = 17). They reported a decrease in yield brought about by flood, lack of water supply, extreme heat, strong winds, and drought. Specifically, crop yield reduction was echoed by the key informants who noted how rice yields turned into husks due to irregular weather patterns. A female farmer from Cupang shared: “I really thought that we were going to harvest 500 sacks of rice. Just only one week before the harvest, it turned out that most our crop yields became husks.” The farmers also noted the intense heat, which resulted in a decrease in yield. One farmer from Cupang had this experience:

> I expected that I would get an increase in rice yields. But because of intense heat, water for irrigation had become scarce. There should be a one-week of supply of irrigation, but water would immediately dry up. I could have earned more if this did not happen.

In addition, they associated frequent rainfall and increased temperature with the spread of pests, insects, and rice diseases. Although aware of disease symptoms in rice, a farmer from Masagana could not explain “what exactly caused it.” Another rice disease he identified was the tungro virus. This disease, which causes complete drying of the crop, is transmitted by green leafhopper. He shared these statements:

There are a lot of pests that are appearing and causing diseases to rice. In the past, we were not using chemicals. Nowadays, we are using more chemicals because of the increasing number of diseases like the one caused by the tungro virus. If the virus hits the rice field, there will be a 40-percent yield loss.

Table 4: *Respondents' Awareness about the Effects of Climate Change on Farming*

	Frequency
Awareness of the effects of climate change on farming	
Yes	19
No	1
Aspect of farming mostly affected by climate change	
Income	3
Rice production	1
Cropping calendar	0
Use of technology	2
Supply of water	13
Access to information on the effects of climate change on rice production	
Yes	5
No	15
Source of information on the effects of climate change on farming	
Government	3
Non-government organization	1
Company	0
Others (People's organization)	1

Table 5: *Respondents' Perceptions About the Effects of Climate Change on Rice Production*

	Frequency	**Rank**
Observed effects of climate change on rice production		
Damage to rice crops due to changing weather patterns	17	1
Decrease in farmland size due to conversion	11	2
Decrease in rice production	10	3
Damage to farmland due to changing weather patterns	9	4

The delay in rainfall and lack of water source were also identified by focus group participants as key barriers to better rice yields. The participants recognized the negative impacts of these inevitable situations, stating that these had resulted in a loss of about 10% to 40%. A focus group participant, who practices rain-fed agriculture, recalled how he became alarmed when his "rice fields dried up due to the scarcity of rainfall, resulting in cracks measuring up to 6 inches deep."

The focus group participants also mentioned the impacts of the changing weather conditions to the quality of the rice crops produced in their farmlands. Three participants also noted how their rice yields turned into husks. One of them shared: "Climate change does not lead to good effects. It's so difficult to produce good quality of rice yields. Our crops do not fully develop. Instead, they turn into husks." Another participant shared how rice can be destroyed at any stage due to stem borer infestation resulting in whitehead damage, which is characterized by whitish panicles and empty grains.

4.4 Awareness and Perceptions of Adaptation Strategies Used in Rice Production

Although the farmers did not mention the term 'adaptation,' the interviews revealed that they continually incorporated adaptation methods as direct responses to climate variability. In fact, as indicated in Table 6, almost all (n = 19) of them had awareness of using adaptation strategies in rice production. This indicates how their coping mechanisms had been transformed by such a long-term shift in weather conditions throughout the years. As one farmer from Malibong Matanda reported: "We keep on discovering new brands of fertilizer and pesticide. We also try different rice varieties." Due to reliance on chemical company representatives (n = 8) and government (n = 4), access to information on using adaptation methods was evident among more than half of the key informants. It should then be noted that the information farmers received from technicians was limited only to improving fertilizer efficiency and pest control, which they considered 'very expensive.'

Table 6: *Respondents' Awareness about the Use of Adaptation Strategies in Rice Production*

	Frequency
Awareness of strategies in rice production for adapting to climate change	
Yes	19
No	1
Access to information on using adaptation strategies	
Yes	14
No	6
Source of information on adaptation strategies	
Government	4
Non-government organization	0
Company	8
Others (People's organization)	2

In Table 7, the use of chemical fertilizer and pesticide (n = 15) was considered one of the most frequently used adaptation responses by the key informants. The application of a particular chemical treatment to rice crops was largely influenced by technicians. According to the informants, these technicians, who work for chemical companies, would usually conduct field demonstrations of treatment products and their methods of application. The majority of key informants had an inclination towards employing short-term strategies to respond to sudden shocks. This was inevitable considering that they admitted that they did not want to spend a lot of money. Hence, they would usually seek alternative solutions which were deemed to be cost-effective. A case in point is how a farmer from Malibong Matanda favored using organic fertilizer over synthetic fertilizer: “I have to use it to lessen my expenses. It is cheaper than the commercially available fertilizer.”

Aside from the use of chemical fertilizer and pesticide, the other frequently used adaptation strategies were planting of new crop varieties (n = 17) and use of technology in farming (n = 14). The practice of switching from one crop variety to another was mentioned by another farmer from Malibong Matanda: “I just have to change crop varieties. It's unlike in the past that I had to use the same crop variety again. Also, this time, what we're using is organic fertilizer which produced better crop yields.” They also reported investing in irrigation motors and power spray. Although considered to be an effective long-term strategy, there was still hesitation in maintaining their long-term use since it would require them to spend more money and thus would reduce their income.

Subsidy in the payment of agricultural machinery had also been provided to the farmers’ and irrigators’ associations in Malibong Bata, Masagana and other villages. These were highlighted by key informants from Masagana who stated that their irrigators’ association received 21 units of agricultural machineries from MAO. In Table 7, the key informants, however, cited lack of money (n = 15) in acquiring adaptation methods as the foremost constraint in applying appropriate adaptation strategies to rice production. Hence, with low financial assets, the farmers struggled with losses as the production costs increased. However, some farmers became resourceful by practicing organic-based farming. A farmer from Malibong Bata, who followed a training module on organic-based farming published by a farmers’ organization, pointed out that this type of farming results in lower expenses yet higher rice yield.

The focus group participants admitted that they were hesitant in employing what they perceived to be more beneficial and effective strategies. This particularly happened to a participant who incurred losses from high production costs of maintaining irrigation. In this regard, an institutional mechanism for granting financial support in the form of crop insurance to the farmers was regarded as a viable solution. For example, in every village, an insurance worth Php5,000 is alternately given by MAO during dry season to each of the selected five farmers who practices irrigated agriculture, and during wet season to each of five farmers who employs rain-fed agriculture. The support given by the municipality was also confirmed by a participant who explained how the municipality subsidized scheme enabled him to buy seeds only at Php900 per sack while the agricultural office paid the Php300 subsidy.

Table 7: *Respondents' Perceptions About the Use of Adaptation Strategies in Rice Production*

	Frequency	Rank
Adaptation strategies used in rice production		
Planting of new crop varieties	17	1
Use of chemical fertilizer and pesticide	15	2
Use of technology in farming	14	3
Diversification of household income	11	4
Development of alternative supply of water	9	5
Change in cropping calendar	8	6
Change in irrigation system	7	7
Availing of crop insurance	6	8
Use of farmland for planting other crops	5	9.5
Coordinating with government, NGOs, or companies for a possible help or support	5	9.5
Increasing area of plantation	4	11
Others (organic-based farming)	3	12
Hindrance in using adaptation strategies in farming		
Lack of money in acquiring adaptation methods	15	1
Lack of information about the help and support from government, NGOs, or companies	9	2
Lack of knowledge about adaptation strategies	7	3.5
Lack of knowledge about climate change	7	3.5

5.0 Discussion and Implications

With limited evidence of climate change, the farmers can only base their perceptions on what they have experienced and observed. Hence, the conceptualization of a human-induced climate change seems to reflect both their perception of its causes and concern for the environment. The perception that climate change can be attributed to humans is also evident in previous studies (Malka, Krosnick, & Langer, 2009; see Jang, 2013, for a review). However, the issue of a human-caused climate change still needs to be confirmed by empirical evidence, eliminating any political and alarmist views associated with what seems to be only a geological and meteorological issue (Carter, 2007). This then implies a need for an information dissemination scheme that focuses on the discussion of climate change as a scientific topic. This can strengthen the farmers' knowledge about how changing climate conditions like rising temperature and frequent rainfall or drought become threats to their livelihood. Eventually, this will transform them from experienced to educated adaptors. This serves then as the starting point of improving their adaptive capacity.

The study also reveals that the farmers perceive serious risks as they become aware of the changes in climate condition. A primary concern is high temperature which, according to them, is likely to affect their health and livelihood. Hence, they expect that unpredictable weather patterns and occurrences of calamities will be more frequent in the succeeding years. This is not surprising at all since most of them have already experienced major disasters like typhoon and flash flood that severely damaged their livelihood. Such perceptions suggest the likelihood of being more vulnerable to future environmental stresses, that is, if they cannot convert their concerns into an attitude inclined toward preparedness. This then highlights the role of both public and private sectors in preparing them to become more resilient to extreme weather conditions.

Moreover, the results suggest that farming in the four villages is at risk from interrelated impacts like damage to rice crops and decrease in yield brought about by extreme weather conditions. As climate change continues to affect temperature and rainfall, soil and groundwater properties are likely to be affected leading to decreased water availability and crop yield (Kang, Khan, & Ma, 2009). Furthermore, high temperature decreases the number of seed yield during the critical stage of flowering (Wheeler, Craufurd, Ellis, Porter, & Prasad, 2000). It also aids in pest infestation while environmental stresses bring about higher vulnerability risks among crops (Strand, 2000).

From the farmers' point of view, increased temperature and frequent rainfall are the driving forces of these impacts. Their concern on the changing temperature and rainfall seems to encompass other problems such as pest infestation and lack of water supply. This only indicates that the farmers face a combination of risks as they view climate change as a long-term event directly affecting them. It implies that their approach to risk management should require a carefully determined combination of strategies based on their existing resources.

Aside from consistently employing common adaptation measures, the farmers also look for alternative strategies suitable for their farm conditions. They utilize either autonomous or conscious responses or a combination of both measures. Such actions reveal how the farmers have diversified and combined various approaches suitable for existing conditions by utilizing their own knowledge, experiences, skills, and resources (Habiba, Shaw, & Takeuchi, 2012). Most of the farmers interviewed had embraced new farming techniques and technologies while still maintaining the use of traditional coping strategies. Others had sought assistance and support from the government through the formation of an organization. Their responses can be categorized as either autonomous or conscious. According to Bryant et al. (2000, as cited in Dang, Li, Nuberg, & Bruwer, 2014), the former refers to those measures implemented solely by the farmer—planting new crop varieties, change in irrigation system, diversifying household income—while the latter focuses on the interventions provided by the government—availing of crop insurance, use of technology in farming.

Their long years of engagement in farm supervision may have influenced their deliberate actions to adapt. The information they acquire from chemical companies and local government may have also transformed their adaptation practices. This is especially important for those who solely rely on farming as their source of livelihood. However, it seems that there are more farmers who have access to information on adaptation measures from companies than from the government. Since chemical company representatives are more likely to be in contact with farmers to promote agrochemical products and recommend their effective uses, there is a tendency for farmers to believe in such recommendations and apply them as long-term adaptation strategies. This indicates the need to also inform farmers regarding the health risks associated with continuous agrochemical use. This indicates a more conscious effort from the government to reach out to and inform a larger number of potential farmer adaptors. Moreover, there is hesitation among farmers to adopt the use of chemical fertilizers and pesticides due to high costs. This highlights the provision of financial capital to farmers who have difficulty in making long-term adaptive decisions due to lack of economic resources. A greater challenge emphasizes how the public and private sectors can transform farmers' coping strategies to short-term climate variability into adaptation measures to long-term climate changes.

6.0 Conclusion

This study has examined farmers' awareness and perceptions of climate change and its impacts to their rice production. It has also determined the measures they undertake as they adapt to perceived climate variability and changes. Although they have limited knowledge of climate change due to lack of information access, the farmers generally perceive that changes in climate conditions have caused considerable effects to temperature and rainfall. Such changes have posed serious challenges to water supply and have brought negative impacts like damage to rice crops and decrease in yield. Despite facing these risks, they manage to utilize a combination of adaptation measures like planting of new crop varieties, use of chemical fertilizers and pesticides, use of technology in farming, diversification of household income, and development of alternative supplies of water. However, the lack of financial resources hinders them from utilizing new adaptation techniques and technologies, which they perceive to be more appropriate and beneficial. The study also emphasizes the importance of determinants of institutional support, availability of resources, access to information, and availability of social networks to enhance their adaptive capacity. This improvement, in order to be successful, should transform their coping strategies to adaptation measures. It is in this context that the interplay of the determinants must be executed in a setting favorable to the farmers.

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