Effects of Climate Change in Farming Practices: The Case of Selected Barangays in San Mateo, Isabela

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***Abstract*—The agricultural sector is one of the more vulnerable sectors to climate change. The Local Government Units (LGUs) in the Philippines have only started to incorporate measures into local plans to mitigate or adapt to its adverse effects. The paper examined the farming practices of farmers in San Mateo, Isabela and how they have adjusted to climate adversities. Primary data was gathered through survey questionnaire, while focus group discussions and key informant interviews were conducted to verify the findings. Secondary data gathering was done to supplement primary data gaps. The municipality showed high potential for adaptation through farming practices of farmers. Findings show awareness to adverse effects of climate change, resulting to adjustments in farmers' activities. Dependence on water supply from Magat River Integrated Irrigation System (MRIIS) affects farming schedule, as most of the agricultural lands are irrigated, resulting to changes from traditional farming to more updated techniques. The LGU must recognize the need to educate farmers through trainings and extension education to build farmers' adaptive capacity. The shift in the mindset of farmers makes it easier to introduce new technology, and innovative farming practices already being practiced may be further enhanced through programs and projects of the local government.**

***Index Terms*—climate change, adaptive capacity, drought, cropping patterns**

I. Introduction

The agricultural sector has been deemed as one of the more vulnerable and sensitive sectors to have been affected by the changes in the climate. Damage in agriculture worldwide and locally has been devastating, and losses immeasurable. The Philippines is one of the countries severely hit by the effects of climate change. The country averages around 19 to 22 tropical cyclones and other forms of weather disturbances in a year. Recent events show that the weather disturbances have become more frequent, and even more severe.

Efforts at addressing the adverse effects of Climate Change by the government are found in the different legislations. Legislations issued at the national level have been translated into programs and projects by various line agencies in an effort to adapt to the effects of climate change.

Measures have also been taken at the local level. However, there is still much to be done. Local planning, for instance, has yet to integrate mitigation and adaptation measures into their local plans, particularly in the agricultural sector.

Agriculture is identified as the main economic driver in the Municipality of San Mateo, Isabela. With climate hazards perpetually plaguing the municipality, there is a need to look into the present farming practices of farmers, and identify areas and opportunities for adaptation to hazards affecting the municipality.

II. Literature Review

A. Vulnerability of the Agricultural Sector to Climate-Related Hazards

The Intergovernmental Panel for Climate Change (IPCC) defines vulnerability as "the degree to which a system is susceptible to and unable to cope with the adverse impacts of the climate change, including climate variability and extremes" [1].

The IPCC identified the Asian Region to be one of the areas most likely to have increased exposure to extreme climate-related stresses such as fire risks, typhoons and tropical storms, landslides, floods, and severe vector-borne diseases (IPCC, 2007). The report also noted water and agricultural sectors as being the most sensitive to climate-induced hazards.

B. Adaptive Capacity as a Means to Cope

Adaptive Capacity may be defined as "the ability of farmers to adjust to climate change, to temper/lessen potential damages, and to take advantage of opportunities or to cope with consequences" [2]. According to Klein *et al.* [3] adaptation takes on a more bottom-up approach, in which private actors, local communities, regional & national governments need to take actions.

The Philippines is signatory to international treaties and agreements that seek to address the growing problem of Climate Change worldwide. Geographically, the country is situated within the typhoon path in the Pacific Region, a part of the globe that is frequently hit by weather disturbances. With regard to Philippine laws and

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legislations, the National Framework Strategy for Climate Change 2010-2022 [4] recognizes the need for the country to build its resilience to the adverse effects of climate change, identifying key areas that deemed most sensitive to these weather conditions. The Climate Change Act of 2009 [5] also looks into how Climate Change shall be adapted by local government units (LGUs). The Department of Agriculture (DA) Policy and Implementation Program on Climate Change which was signed in 2009, targets local level adaptation in the agricultural sector.

C. The Need for Climate Change Adaptation at the Local Level

Studies both at the local and international level have revealed that Climate Change adaptation in developing countries is most effective at the local level. Chapter 6 of "The Economics of Climate Change in Southeast Asia: A Regional Review" [6] stresses on the importance of adaptive capacity building and enhancement from the national to the local level.

It should likewise be noted that Climate Change Adaptation is context-specific, with efforts stemming from the grassroot level. (IPCC, 2007). This is due to its dependence on the climatic, environmental, social, and political conditions, or specific circumstance in the target area [7]. "Farm-level adaptation practices" has likewise been identified as another priority area in enhancing adaptive capacity.

Literature review stresses that adaptation is a bottom-up approach, and is context-specific. Several studies have already been conducted illustrating farmers' awareness and knowledge on the adverse effects of climate change on their farming activities, and subsequently their willingness and ability to cope. In a study conducted by Ngilangil, *et al.* [8], farmers from four (4) provinces in Region I were surveyed, and their level of knowledge and awareness on Climate Change and potential adaptive responses were looked at, as well the issues and problems that the adoption of adaptive strategies. This further denotes that adaptation is most effective at the local level, underscoring the role of farmers in adapting to climate change.

III. Objectives

The paper aimed to observe how the farmers in the Municipality of San Mateo, Isabela able are to cope with the adverse effects brought by the changes in the climate. Specifically, the paper set out with the following objectives:

1) To examine the effects of climate change in the municipality's agricultural sector;
2) To determine the adaptive capacity of the farmers to the hazards brought about by climate change; and
3) To recommend adaptation measures or policies that may be considered/incorporated into the preparation of future plans of San Mateo.

IV. Methodology

The study was conducted in the Municipality of San Mateo, Isabela, specifically in selected agricultural barangays. As climate change is context-specific, the Case Study Method was utilized.

Prior to the primary data gathering, Secondary Data Gathering was done through the conduct of Documentation Reviews, where empirical data were culled from the various reports and plans generated by the municipality.

Primary Data Gathering was conducted through survey of selected barangays. The findings in the survey were further supplemented with Focus Group Discussions (FGDs) with identified stakeholders. The data gathered on field was likewise cross-referenced with Key Informant Interviews (KIIs). A separate questionnaire was utilized for the key informants.

The study covered selected agricultural barangays of the municipality. Three (3) of thirty-three (33) barangays were selected using the following criteria:

- Barangays with largest farming population;
- Barangays that are constantly plagued by Drought, Typhoon, and Flooding; and
- Barangays that have experienced the largest damage brought by climate-related hazards in terms of agricultural.

Using stratified random sampling, a survey was conducted on 206 farmers from the three selected barangays. The criteria for selection of the survey population were: that they were listed in the master list of the farming population; that they are actively involved in farming activities; and that their farmlands are located within the barangay, and not outside of the municipality.

V. Study Area

Located at the southwestern portion of Isabela in the northern Philippines, the 1st Class Municipality of San Mateo has been declared as an "Agro-Ecological Destination", and thrives on not only rice production, but also on other alternative farming practices In its bid to become an "Agroecological City", efforts have been continuously poured into the agricultural sector by the local government.

San Mateo is composed of 33 barangays, four (4) of which make up the poblacion, or the urban area, while the rest of the 29 are devoted to agricultural activities. The latest census reflects the municipality's population at 69,947 people in 12,059 households. According to the San Mateo Comprehensive Land Use Plan 2012 to 2021 [9], a major portion (around 80%) of the municipality has a generally flat terrain. Owing to over 150 kilometers of irrigation facilities installed by the National Irrigation Administration (NIA), all of the municipality's agricultural lands are now irrigated, and supplied by the Magat River Integrated Irrigation System (MRIIS).

The three agricultural barangays that were selected to be surveyed are as follows:

Barangay Bagong Sikat
- Total land area of 475 has.
- Total population of 2,752
- Farming population numbers to 144 farmers.

Barangay Estrella
- Total land area of 369.80 hectares
- Total population of 1,515
- Farming population numbers to 216 farmers.

Barangay Old Centro 1
- Total land area of 274.16 hectares
- Total population of 1882
- Farming population numbers to 109 farmers.

VI. FINDINGS

A. *Respondents' Profile*

1) Socio-Economic profile of surveyed farming population

Of the 206 farmer respondents the respondents' Socio-Economic Status were gathered:
- Around 162 respondents (79%) are household heads;
- Majority of the respondents (around 141, or 68%) are married, while 49 (24%) have been widowed, while 16 (8%) are single;
- Around 68 (33%) of the surveyed farming population are within the 56 to 65 year old range. Fifty-one (25%) fall under the 46 to 55 bracket, while 42 (20%) are within the 36 to 45 range. None of the interviewees were under 35.
- Almost half (85 respondents, or 41%) were at the high school level, or finished high school. Another 62 (30%) were at the elementary level, while 48 respondents (23%) reached college.

B. *Agricultural Production in San Mateo, Isabela*

Rice is the municipality's primary crop, and the presence of Magat Dam Reservoir, as well as several water tributaries within its boundaries, allows for two croppings a year. The "Rice-Rice-*Munggo*", or "*Munggo* after Rice" cropping pattern is most practiced. The soil type (sandy loam) makes it ideal for farmers to plant rice. Sandy loam soil type tends to absorb water faster and needs frequent irrigation. Of the respondents, 191 (93%) consider rice as their primary crop. *Munggo*, or mung bean, has become widely popular in the municipality as a secondary crop to plant, as it grows well in warm weather, making it ideal to plant right after the second cropping in March and April to help restore the fertility of the soil.

C. *Climate Change Awareness of Farmers in San Mateo, Isabela*

The following problems are seen to be experienced by the municipality: weather disturbances such as flooding, typhoons, tropical storms, and the like, excessive rains from La Niña, and drought caused by the occurrence of El Niño, are a cause for concern, especially among farmers [10].

1) Observed changes in the weather pattern

During the survey, the respondents were asked what changes in the weather they particularly observed over the past five years. All respondents observed that recent years have exhibited "More frequent hot days and hot nights". The second most observed weather change was "Drier season from March to May". The third most observed change in the weather was "Stronger Typhoons". Many of the farmers are aware of the growing strength of typhoons; for instance, the addition of Public Storm Warning Signal (PSWS) No. 5 is now the newest storm category. Fig. 1 reflects the most observed changes in the weather by farmers in the municipality:

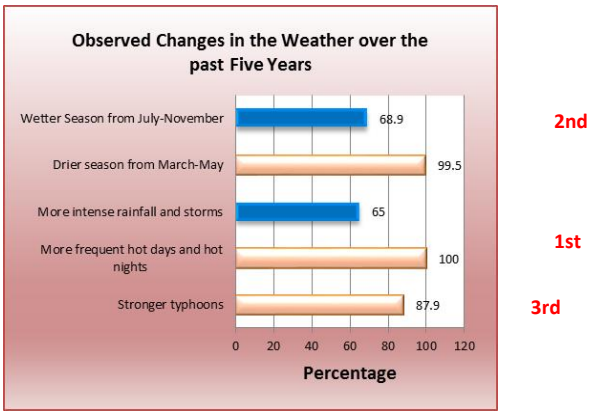

Figure 1. Observed weather changes (past 5 years)

2) Climate-Related hazards that affect farmers' livelihood most severely

In determining the climate-related hazards affecting the municipality, farmers to were asked to rate the frequency of occurrence of each hazard (3 for Always, 2 for Sometimes, and 1 for Never), and the level of severity of each hazard when they occur (5 being the Highest and 1 being the Lowest).

While typhoon and flooding in some parts of the three barangays are felt during the rainy seasons, drought has become more prevalent in the past years, and is becoming more a cause for concern to the farming community, particularly when water supply is scarce, and the Magat Dam Reservoir cannot service all of the irrigated lands.

Fig. 2 shows the result of the farmers' rating of frequency of each hazard:

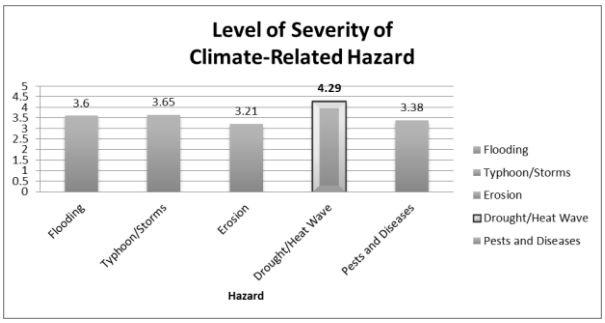

Figure 2. Level of severity of climate-related hazard

Factors that have exacerbated the occurrence of drought in the local government include:
- The municipality's dependency on irrigation facilities. Due to the recent changes in the weather,

the municipality now experiences bouts of droughts/dry spells (about one to three months in a year).

- The municipality's soil type - sandy loam - can be very sensitive to dry spells, and needs to be regularly fed with water on a weekly basis

In 2010, the municipality experienced one of its worst losses in agriculture during the occurrence of drought throughout the country. In the 2nd quarter of 2015, the whole province of Isabela experienced another prolonged dry spell, which pushed back the municipality's planting calendar by a month.

3) Effects of climate-related hazards on farming activities

Respondents were asked how the identified climate-related hazards affected farming activities/crop production. Nine of the ten possible effects scored high, and of the nine, the five most observed were "Decrease in water availability", "Decline in yield and production", "Decline in soil moisture", "Income loss from production", and "Low yield (local rice variety not tolerant to drought)".

The cropping calendar/cropping schedule is determined by the water supply at Magat Dam. Normally, the first cropping of rice begins in May, and harvest time in September. Second cropping commences in the month of November, and harvest is in late February; after which, *munggo* is grown from the months of March to April.

This year, however, water supply has become scarce – the municipality's cropping calendar has been pushed back a month following the prolonged drought currently being experienced across the province. Owing to the tight cropping schedule of the municipality, any movement in the cropping calendar shifts all activities, and harvest of the second cropping cycle may move from September to October, where strong typhoons normally plague the municipality.

4) Awareness and level of knowledge on climate change

Respondents were then asked if they ever heard of the term "Climate Change" before the interview was conducted, and 139 (68%) of them answered YES, while 65 (32%) answered NO.

Those who answered YES were then asked to describe climate change. Varied answers were given, and the most common were the following:

- Climate change is the erratic weather conditions being experienced;
- Climate change is manifested through higher temperature (recent years have seen the temperature rise to as high as 42 ℃ from the usual 38 ℃);
- Dry spells are now prolonged;
- Climate change brings about warmer days and very cold nights as well; and
- Very evident change in climate (there is no rain when there should be already, and the heat is unusual as well).

5) Awareness on climate change variances

Awareness of respondents to Climate Change Variances was subsequently looked into. From a list of variances, they were asked to rank each variance from a scale of 1 to 5 (5-Very Highly Aware, 4-Highly Aware, 3-Aware, 2-Somewhat Aware, and 1 for Not Aware). Table I below reflects the list of climate variances farmers ranked based on their observations:

TABLE I. AWARENESS OF RESPONDENTS TO CLIMATE CHANGE

Awareness of Respondents on Climate Change Variances	Ranking (1st - Least Aware)
Seasonal changes in rainfall, temperature could alter growing seasons, planting/harvesting calendars	**10** 1st
Warmer climate may reduce flexibility in crop distribution and increase irrigation demands	**9** 2nd
Climate change leads to changes in irrigation water availability	**8** 3rd
Landslides and flashfloods not only destroy the lands but also destroy irrigation canals, and other farming facilities	7
Crop production is at great risk during extreme weather events	6
Climate change increases weed and pest population	5
Climate change alters land suitability	4
Climate change intensifies and disrupts water cycle	3
Changes in the weather is a global issue/problem	2
Landslides and flashfloods not only destroy the lands but also destroy irrigation canals, and other farming facilities	1

The three variances that scored the highest in terms of Farmer Awareness are the following:

1. Seasonal changes in rainfall, temperature could alter growing seasons, planting/harvesting calendars;
2. Warmer climate may reduce flexibility in crop distribution and increase irrigation demands; and
3. Climate change leads to changes in irrigation water availability

All three relate to the identification of Drought as being the hazard that severely affects agricultural activities in the municipality. Overall, all the Climate Change Variances scored "Very High" in terms of respondents' awareness to them, showing that farmers are privy to variances resulting from climate-related hazards.

D. Adaptation Measures (Present and Potential)

1) Potential adaptation measures

Respondents were presented with a list of potential adaptation measures that may be adopted into one's farming practices. On a scale of 1 to 5 (5-Always Adopted, 4-Often Adopted, 3-Sometimes Adopted, 2-Seldom Adopted, and 1 for Never Adopted), respondents were asked to rate each strategy on which ones they widely use, to those they seldom or have never used. The resulting overall mean of 3.69 suggest that they often adopted the different strategies. Table II below reflects the potential adaptation measures that are either already being utilized or adopted by them into their farming activities:

TABLE II. POTENTIAL ADAPTATION STRATEGIES

Potential Adaptation Strategies	Ranking	(1 - Least Adopted)
Review/Adjustment of Cropping Calendar	**10**	**Always Adopted**
Forecasts and early warning systems and protection measures to natural disasters	**9**	**Always Adopted**
Adjusting/timing of farm operations (planting data/calendar)	**8**	**Often Adopted**
Suitable crop species/climate-resilient varieties under the changed rainfall conditions	**7**	**Often Adopted**
Develop simple measures for rapid harvesting and post harvesting	**6**	**Often Adopted**
Livelihood Diversification (alternative livelihood sources)	5	Often Adopted
Training on alternative income generation skills	4	Often Adopted
Use of soil moisture conservation measures (e.g. mulching)	3	Often Adopted
Restoration of degraded lands	2	Sometimes Adopted
Rainwater harvesting	1	Never Adopted

As reflected in Table II, the top five Potential Adaptation Measures selected by the farmers are as follows:

- Review/Adjustment of Cropping Calendar;
- Forecasts and early warning systems and protection measures to natural disasters;
- Adjusting/timing of farm operations (planting data/calendar);
- Suitable crop species/climate-resilient varieties under the changed rainfall conditions; and
- Develop simple measures for rapid harvesting and post harvesting.

Since around 99% of the lands of respondents are irrigated, Rainwater Harvesting ranked the lowest. Farmers ranked "Review/Adjustment of Cropping Calendar" as the adaptation strategy they most often adopt. The adjustment of farmers' cropping calendar could already be an indication of their response to the occurrence of drought, which is already becoming a prevalent problem not only in the municipality, but throughout the region. Another adaptation measure that scored high "Forecasts and early warning systems and protection measures to natural disasters" may stem from the presence of Early Warning Systems provided in the barangays, and from the direct involvement of farmers in the maintenance and upkeep of the irrigation facilities.

2) Modification of farming practices

Part of determining farmers' adaptive capacity to climate change was to look at modifications in farming practices by the farmers. Survey results show that farmers are already adapting to these changes at the grassroot level, incorporating adaptation strategies into their farming activities. Farmers have also modified/replaced several farming practices in response to the effects of climate-related hazards on their farming, which have been categorized into the following: Crop Diversification, Change in Rice Variety, Change in Farm Inputs, New Farming Methods/Techniques, Land Preparation Activities/Pre-planting, Planting, and Harvesting.

It is interesting to note that of all the farming practices that have been modified by the farmers, Change in Farm Inputs, Crop Diversification, and Change in Rice Variety stem from projects introduced by the local government and the DA; farmers have already started, or are already widely observing these farming practices. This shows that despite their seeming disinterest in trainings and seminars offered, they have, in fact, already picked up on certain adaptation practices. As shared in one of the key informant interviews by an officer of the DA, the shift from good rice to certified rice, is one of many DA-led efforts implemented through the Office of the Municipal Agriculturist. Vermiculture, organic farming is likewise practiced in the barangays. In Barangay Estrella, it has become a widespread practice for the barangay's Rural Improvement Club President to facilitate the marketing and selling of the excess vermicompost produced by the farmers.

Planting of *munggo* as rotation crop has become part of farmers' land preparation. *Munggo* is known for its soil conditioning properties. The introduction of *munggo* in the municipality was originally met with reservation by the farmers, the mayor at that time devised a "Plant now, pay later" scheme, allowing the farmers to avail of farm inputs, payable after harvest [11].

The DA is likewise introducing farmers to new planting methods such as direct seeding which requires less labor, as opposed to transplanting of rice seedlings, which is the more commonly practiced method. These practices were introduced by the local government and the DA through trainings offered to the farmers.

VII. CONCLUSION

The Municipality of San Mateo has shown high potential for adaptive capacity not only through the programs and projects of the LGU that are already in place, but more importantly, by the activities and practices exhibited by no less than the farmers.

It was observed that even as farmers have already started incorporating adaptation measures into their farming activities, there is still a need to educate and empower them further through trainings and extension education, and this must be initiated by the local government unit. Educating farmers on climate change is the first step to helping build their adaptive capacity.

The local government of San Mateo must also be more aware that the effects on the change in the cropping calendar indicate that planning agricultural activities must now be for the long term. As it is, there are already numerous efforts by the LGU in addressing adverse effects brought about by climate-related hazards. What was noticeable on field was the absence of a plan which puts together all these efforts under an overall goal, and that is addressing the adverse effects of climate change. The shift in the cropping calendar indicates the need for long-term planning by the local government, and this may be done through the drafting of a plan that spells out

specific actions and steps on how to build farmers' adaptive capacity and resilience to climate change.

The need to build farmer's adaptive capacity to climate change is a concern that requires effort from all levels of government. The national government has recognized this, and efforts have been initiated through the creation of laws and mandates. However, as adapting to climate change is a bottom-up approach, the national government shall rely on input from the lower levels, particularly those closest to the grassroots.

A number of issues were observed in San Mateo, which may be considered in the preparation of the municipality's climate change action plan. First, the municipality needs to change farmers' perspective on new technology/knowledge. Farmers rely on what has been tried and tested, that the uncertainty of new knowledge has led some to adopt a "to see is to believe" attitude.

There is likewise a need to close the communication gap between farmers and the government. The municipality may pick up on what farmers are already adapting and build on this. Plans at the barangay level may likewise be consulted, such as the Barangay Disaster Risk Reduction Management Plans (BDRRMP), which may already contain best practices in disasters that are already in place. Moreover, farming practices at the barangay level may also be documented, as these can also feed into the municipality's climate change action plan.

There is a need to strengthen Information, Education, and Communication (IEC) and capacity development of farmers by the LGU. It is fortunate that the farmers in the barangays have already picked up on crucial adaptation measures: crop diversification, change in rice variety, changes in farm inputs, new farming methods/techniques, land preparation activities/pre-planting, planting.

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