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Improving the Use of Weather and Climate Information for Farm Decision Making in Victoria, Oriental Mindoro, Philippines

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Abstract. Weather and climate are crucial factors that greatly influence the agricultural sector, especially in the decision-making process of farmers. A recent study conducted in the municipality of Victoria, Oriental Mindoro, Philippines aimed to evaluate the utilization of climate and weather forecasts in farm operations. The study collected primary data through a household survey using a structured questionnaire, with a total of 324 randomly selected respondents based on Cochran's formula. The findings of the study revealed that a significant majority of farmers, approximately 85%, are aware of climate change. This awareness is heightened by their perception of long-term changes in climate, particularly in rainfall patterns. Farmers recognize and acknowledge the impact of climate change on their agricultural practices. When it comes to obtaining information about weather and climate, the study found that television is the primary source for most farmers. This highlights the importance of broadcasting accurate and timely weather forecasts to ensure farmers stay informed and prepared. Furthermore, the study discovered that weather and seasonal climate forecasts, along with long-term climate projections, significantly influence various farm operations. These operations include the selection of rice varieties, timing of seed sowing, application of fertilizers and pesticides, water management, harvesting and storage, and even selling decisions. The reliance on science-based information is crucial for farmers as traditional knowledge alone is no longer reliable in the face of changing climate conditions. Based on the study's results, it is evident that farmers in Victoria, Oriental Mindoro, require access to science-based knowledge, particularly accurate weather and climate forecasts. The study emphasizes the need for reliable information and other agricultural-related climate services provided by the Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA). Such services can significantly contribute to improving decision-making processes at the farm level.

Keywords: Climate and Weather Information, Climate Change, Farm Decision Making, Victoria

Introduction

Weather and climate play a significant role in agricultural production, especially in developing countries. The extent of weather and climate risks in a particular area, coupled with the stage of crops, determines the impact on agricultural yields (Clarke et al., 2015). Among the developing nations affected by climate change, the Philippines stands as a prime example, enduring the consequences of typhoons, extreme rainfall, floods, and drought (Roehlano et al., 2013). Unfortunately, these adverse effects are increasingly devastating the country's food production, posing a serious risk. To mitigate the challenges posed by climate shocks, it is crucial to embrace innovations and technologies in the agricultural sector. Timely and accurate information, readily available from PAGASA climate products, can be disseminated through enhanced farm weather advisories and monthly. By effectively utilizing accurate forecasts, the risks associated with climate uncertainties can potentially be reduced (Hansen, 2022). However, a significant challenge lies in the gap between the producers and users of weather and climate information. Without effective interpretation and communication at the farm level, the information becomes useless to decision-makers, farmers, and local level planners (Tembo-Nhlema, Vincent, & Henriksson, 2021).

Victoria, one of the municipalities in Oriental Mindoro, is known for its thriving rice production. However, this agricultural commodity has been greatly affected by the changing climate conditions. The occurrence of both flooding and drought, attributed to climate change and variability, has posed significant challenges to rice farming in the area. As a result, farmers are finding it increasingly difficult to adapt to the unpredictability of weather and climate events. The traditional cropping patterns that they once relied on are no longer reliable, leading to uncertainty in farm decision making. According to a study conducted in 2019, farmers expressed the need for accurate weather and climate forecasts to minimize uncertainties. It is believed that if these forecasts are effectively communicated, understood, and integrated into the local decision-making process, they can help mitigate the impact of climate-related challenges on rice production.

To strengthen dissemination and utilization of climate and weather information, a study was conducted in Victoria, Oriental Mindoro, Philippines. This study focused on improving the use of weather and climate information in farm decision making. It assessed how farmers in Victoria utilize climate and weather information as a tool for making decisions related to farming. Additionally, the study aimed to understand the influence of weather and climate events on farming decisions. The results of the study also identified the information needed by farmers and highlighted the gaps in their knowledge, access, and use of weather and climate information. Based on these findings, recommendations were made to enhance the utility of forecasts and their application in decision-making processes. The overall objective of this study is to improve the use of weather and climate information in farm decision making in Victoria, Oriental Mindoro, Philippines. Specifically, it aims to: 1. Determine farmers' understanding and awareness of climate change; 2. Identify the sources of weather and climate information used by farmers; 3. Determine how farmers utilize climate and weather information in their farming decisions and planning; 4. Understand farmers' preferences regarding weather and climate information sources, lead time, accuracy, and frequency; 5. Identify farmers' information needs and the gaps in their knowledge, access, and use of weather and climate information; 6. Recommend policies and programs to enhance the use of climate and weather information in farm decision making.

Materials and Methods

Description of the Study Area

The Municipality of Victoria is 34 kilometers from Calapan City, the provincial capital of Oriental Mindoro. Victoria is bounded on the north by the Municipality of Naujan, on the southeast by the Municipality of Socorro, and on the southwest by the Municipality of Sablayan, one of the Municipalities of Occidental Mindoro. Victoria covers a total land area of 25,494.4219 hectares and has a total of 32 barangays, 5 of which are urban, while the rest are considered rural. The economic base of the municipality is basically agricultural with almost 30% of its total land area being utilized for production of different crops and agricultural commodities. Victoria utilized about 11,773.58 hectares of the municipality’s agricultural area. About 45.60% of the agricultural lands are devoted to rice farming; 4,062.224 hectares of the total rice area is irrigated which is distributed to 25 barangays. While 422.68 hectares of it is potential irrigable land located in Barangays Macatoc and 804 hectares rainfed area is located in Barangays San Juan and Bagong Buhay. In terms of the volume of production, rice accounted for 49.25% of the total agricultural production of the municipality (Carol, 2022).

Victoria Municipality, located 34 kilometers from Calapan City, serves as the provincial capital of Oriental Mindoro. This vibrant municipality is bounded by the Municipality of Naujan to the north, the Municipality of Socorro to the southeast, and the Municipality of Sablayan to the southwest, which is one of the Municipalities of Occidental Mindoro. With a total land area of 25,494.4219 hectares, Victoria encompasses 32 barangays, of which 5 are urban while the remainder is considered rural.

The backbone of Victoria's economy lies predominantly in agriculture, with approximately 30% of its land dedicated to the production of various crops and agricultural commodities. Specifically, the municipality utilizes around 11,773.58 hectares of its agricultural area. Among the agricultural lands, a significant portion of 45.60% is devoted to rice farming. Out of the total rice area, 4,062.224 hectares are irrigated, benefiting 25 barangays. Additionally, there are 422.68 hectares of potentially irrigable land in Barangays Macatoc, along with 804 hectares of rainfed area located in Barangays San Juan and Bagong Buhay. Remarkably, rice production accounts for 49.25% of the municipality's total agricultural output (Carol, 2022).

The agricultural sector in Victoria Municipality plays a critical role in sustaining the local economy and ensuring food security for its residents. The vast expanse of agricultural land dedicated to rice cultivation highlights the municipality's commitment to meeting the demand for this staple crop. While Victoria's progressive approach to modern farming techniques has brought higher yields and increased productivity to its irrigated rice fields, the severe impact of climate change threatens the sustainability of this agricultural practice. Rising temperatures, changing rainfall patterns, and the potential for water scarcity pose significant challenges. It is crucial for farmers, policymakers, and researchers to collaborate and implement adaptive and mitigative measures to ensure the long-term viability of rice farming in Victoria. By harnessing the potential of its agricultural resources, Victoria Municipality not only contributes to the overall economic growth of Oriental Mindoro but also serves as a prime example of sustainable agricultural practices.

The Conceptual Framework of the Study

Agricultural production is sensitive to weather and climate, thus directly affected by climate change (climatological hazards) such as intense and heavy rainfall, drought, La Niña and El Niño phenomenon and climate variability (hydrometeorological) hazards such as tropical cyclones, Intertropical Convergence Zone (ITCZ) and thunderstorms that may bring heavy rains (Tembo-Nhlema, Vincent, & Henriksson, 2021). Weather and climate related hazards may pose risks to rice farming such as submergence to flood and wilting specially to new planted rice for the rainfed rice areas. These may result in crop loss and adversely affect agricultural economy (Antle, 2016). Scientists and researchers support the potential value of accurate weather and climate forecasts in agricultural production (Quan et al., 2006). Weather forecasts and climate information can help the agricultural sector reduce weather and climate uncertainty (Ash et al., 2007; Westra & Sharma, 2010), only if the forecast is accurately communicated and understood, and integrated into the decision process. The process could help farmers adapt and become resilient to weather and climate hazards (Zuma-Netshiukhwi, Stigter, & Walker, 2016). However, there are certain gaps in delivering or disseminating climate and weather information that affect forecast utility. There are a number of limitations in the application of weather and climate forecasts and other agricultural related climate services to end users most especially in developing countries particularly poor farmers (Archer, 2003; Stigter et al., 2016; Ziervogel & Downing, 2004).

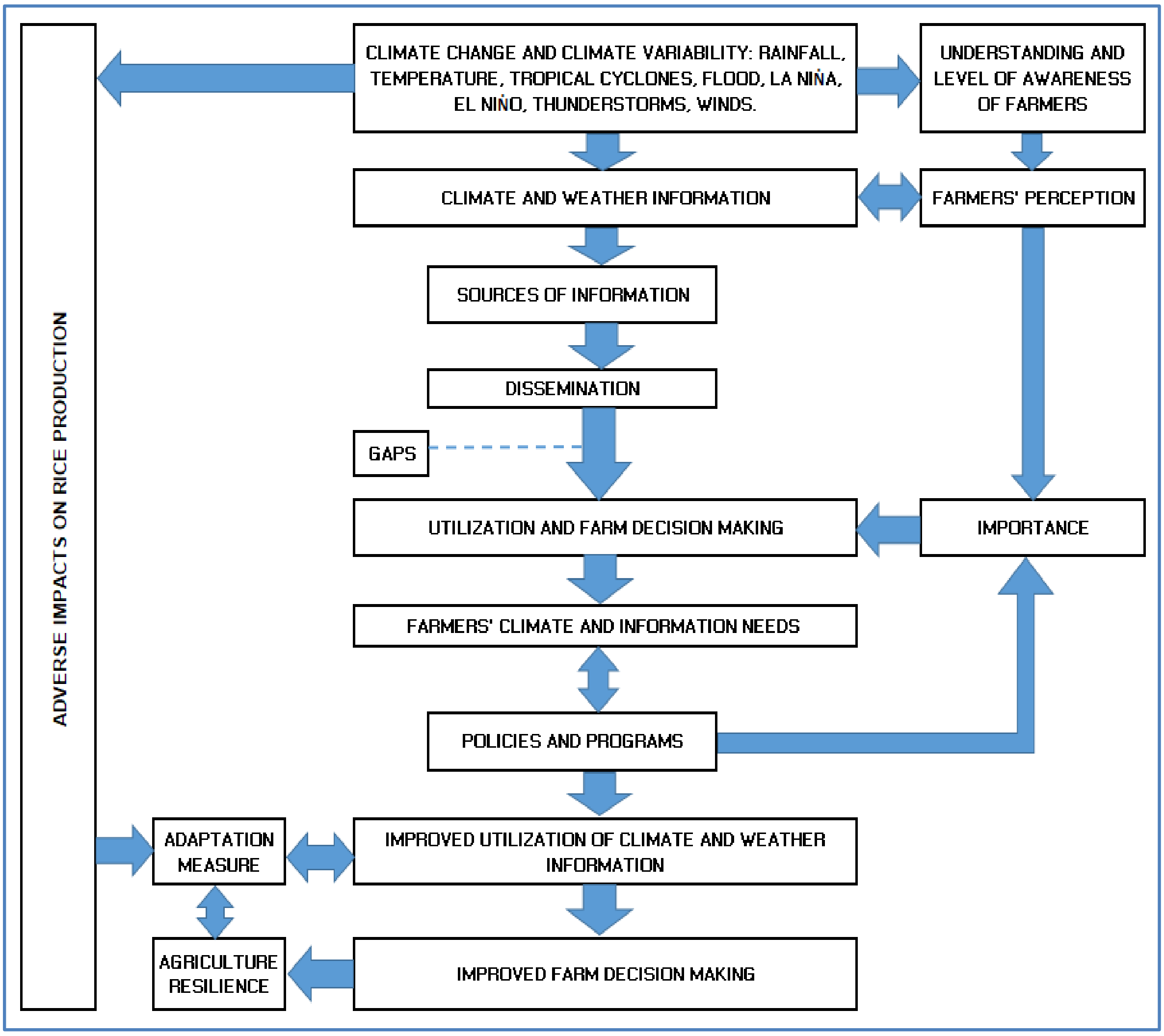

Figure 1. The conceptual model of the study

Crop failures are often a result of insufficient agrometeorological and climatological products associated with poor channels to transfer information to end users accurately. One of the factors contributing to the problems in information dissemination is the absence of well-trained and established extension services on climate related issues. This problem is associated with a continuous need to translate technical information into an easily understood format. There are gaps between producers and providers from the national, provincial, regional, and local networks and the users of the weather forecasts, climate predictions and other climate services in farm level decision making (Tarchiani et al., 2018). Another gap that may arise is how to encourage the farmers for the adaptation of agrometeorological information and services for farm decision-making (Stigter et al., 2016). This theory suits the study on the level of awareness of farmers on climate change. How they perceive climate change impacts is an effective network in crafting their interest and familiarizing them with a science-based knowledge. The decision of farmers affects how the impacts of climate change and weather-related hazards are understood. The utility depends on the way farmers appreciate the importance of the forecasts to adapt to the changes. Thus, farmers' decision goals were related to their perceptions of long-term climate change (Sabine & Elke, 2004). By studying farmers' perception, information needs and the gaps rolling out between information providers, disseminating agents and the end users, policy makers were given the chance to formulate programs and policies to technically enhance the information flow that will significantly result in better utilization. Improved utilization of weather and climate information is one of the strategies in adapting to the impacts of climate change and the impending threat of weather-related hazards. Strengthening the networks for a science-based weather and climate information and its farm level utilization increases agriculture resilience.

Data Gathering and Analysis

Primary and secondary data was collected to satisfy the research's objectives. Primary data was gathered through a household survey of randomly selected farmers in Victoria, Oriental Mindoro, Philippines. A structured questionnaire was provided as a guide during the field interview. The questionnaire elicited information on farmers' understanding and level of awareness of climate change and use of weather and climate information. A focus group discussion (FGD) was also conducted to selected rice farmers to validate some of the information gathered in the structured questionnaire. Farmers were also asked about the importance of science-based climate and weather information compared to the traditional knowledge in farm decision making. They were asked about how their understanding on climate change affects their appreciation on the application of science-based information in farm decision making. The secondary data was gathered from the Municipal Agriculture Office (MAO) in which the data on rice area, rice production and the description of the municipality was collected. The total number of that was taken from the MAO's office was used as the basis for selecting the appropriate number of respondents for the study. Out of the 2,200 total farmers of Victoria, 324 farmers were selected through random sampling. Random sampling was carried out using Cochran formula to calculate the ideal sample size. The Cochran's formula is shown below (Cochran, 1977):

$$n_0 = \frac{z^2 \cdot p \cdot (1-p)}{e^2}$$

Where: e is the desired level of precision (i.e. the margin of error), p is the (estimated) proportion of the population. *The z-value is found in a Z table*.

Enumerators were hired to conduct the house-to-house interview. There were 6 hired enumerators who underwent training before going to the field. The training was conducted to teach and train the enumerators about the process of field enumeration and to familiarize with the structured questionnaire. This is done to assure the reliability of data gathered in the field. Field testing was conducted to acquire expertise under field and to ensure the credibility and validity of the questionnaire. Field supervisors were also hired and trained to do the quality checking and do the specific correction before the final questionnaires sent to the encoders. To analyze the result, the study used a quantitative and qualitative research method. Descriptive statistical analysis using Microsoft Excel was used to generate tables and graphs. The results are shown in graphical and tabular form. The study also used a developmental research design wherein after analyzing the result of the study, policies and programs were drawn to improve the use of weather and climate information in the Municipality. The policy recommendations will serve as one of the climate risk management practices that could help lessen the adverse impact of weather and climate change hazards in rice production.

* https://www.statisticshowto.com/tables/z-table

Results and Discussion

Farmers' Understanding on Climate Change and their Level of Awareness

Farmers' understanding

The farmers were asked about how they understand climate change. A set of qualifiers were laid down to the farmers to determine their understanding on climate change. The interviewer asked using a specific indicator of which they can choose. From the 325 farmers interviewed, 85% of this has an idea of climate change while only 16% has no idea. Farmers were also asked to describe what climate change is, most of them (168 farmers) described th2qwsaat climate change is an increase and decrease in atmospheric temperature and 76 farmers described climate change as an increase or decrease in rainfall intensity, frequency, and duration. The farmers were also asked about the occurrence of climate change that is evident to them. Majority of the farmers (115) believed that the frequency of climate change is seasonal manifestation, while 71 farmers believed that the frequency of climate change is a daily manifestation. Most of them understand and believe that climate change is the change in climate variables shown in the figure. Many of the farmers or 257 of them believe and think that change is a natural occurrence while 235 farmers believe that climate change is caused by humans and 201 farmers believe that climate change is caused by La Niña and El Niño Phenomenon.

Level of awareness of farmers on climate change

Almost all farmers or 320 out of 324 are aware that the temperature nowadays is changing. 310 farmers observed that there are significant changes in observable temperature. Farmers perceived that temperature today is hotter than the usual dry season; hence, 60 farmers observed that the climate today is colder than usual rainy season. Many of them or 307 farmers are aware of the long-term rainfall changes among the responses 132 farmers noticed that the onset of the rainy season is delayed, and 91 farmers perceived that the amount of rainfall today is lower than the usual rainfall amount in the past (Figure 2). The farmers perceived the changes in climatic condition through their experience in farming from now and then. Farmers have a high level of awareness on climate change because they physically feel it in the field. The cropping pattern in which they traditionally follow is not any more reliable at this time since changes in the amount and onset of rain and dry period drastically changed. Farmers appreciate that the traditional belief in farming is not anymore applicable during these times that they already perceived the changing climatic conditions which they have foreseen the increasing risk it may pose in farming activities. On the other hand, 307 farmers are aware that there are changes in drought occurrence over the past 30 years while only 17 farmers are not aware. 210 farmers are already experiencing drought and expressed that they do not experience drought before while 60 farmers responded that there is a more frequent occurrence of drought in the locality.

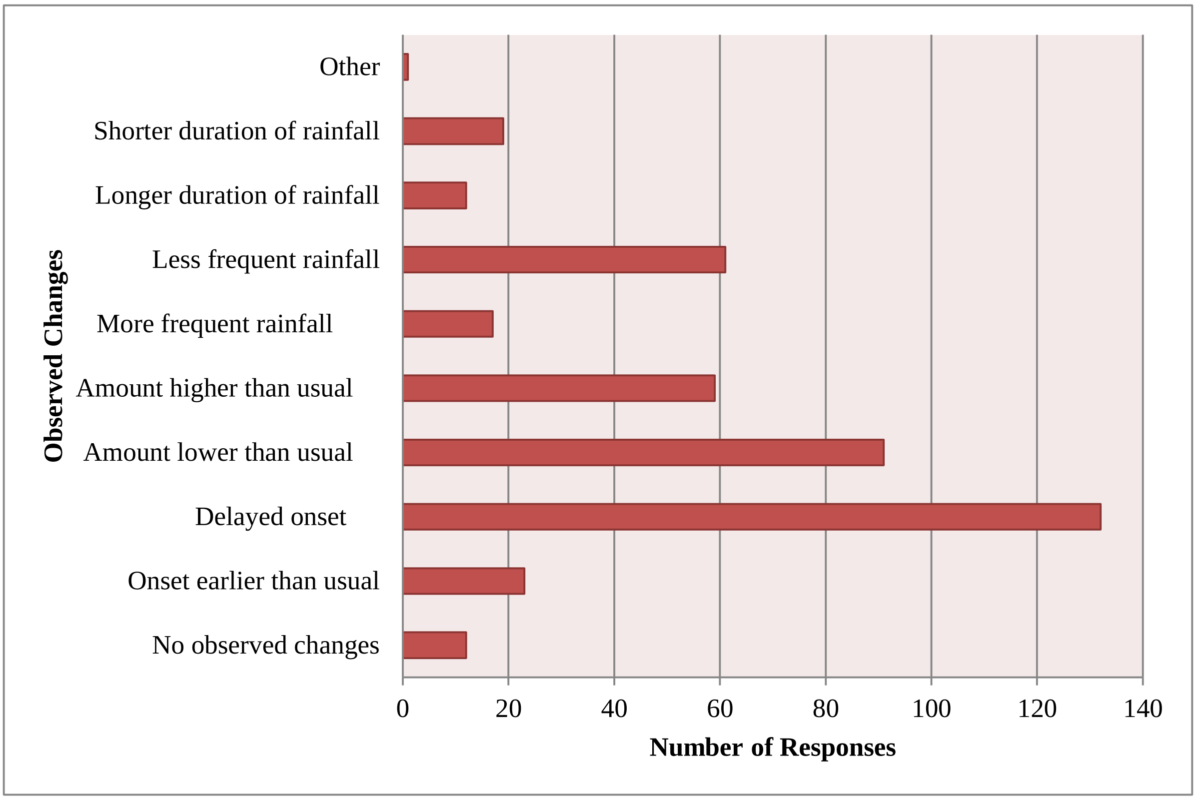

Figure 2. Long-term changes in rainfall observed by rice farmers, Victoria, Oriental Mindoro, 2019

The Sources of Weather and Climate Information

Majority of the farmers acquire information from the television, while some of them acquire it from mobile phones and radio.

In the case of flooding, 253 farmers responded that there are changes in flood occurrence while 71 farmers are not aware such phenomena are happening in their locality. 100 farmers observed that the flood level is increasing in their area and 83 farmers observed that there is a frequent occurrence of a flood. On the contrary to the increasing amount of rainfall, most of the farmers or 305 of them, expressed that there are changes in the water availability in their farms. 280 farmers agreed that there is less water availability to irrigate their lands. On the other hand, 298 farmers noticed that there is an El Niño occurrence while 256 farmers agreed that there is also a La Niña occurrence in their locality.

Out of 324 respondents, 305 of them acquired information from television while 28 and 26 respondents acquired information from radio and mobile phones, respectively. Nevertheless, only 5 farmers acquire information from PAGASA webpage. Very seldom farmers acquire information from co-farmers. The respondents were asked to select as many as they can to where they acquire the information. Specific weather and climate parameters were laid down to the farmers and thoroughly asked to point out specific sources of each climate and weather parameters. Most of the farmers acquire weather and climate information from the television. This is because television is the main medium of which news and information is accessible to them. Some of the farmers are still using radio to acquire the information and some of them who can afford cell phones use it to acquire the same information, especially farmers who have children who can manage cell phones for them (Table 1).

Table 1. Sources for each weather and climate information, Victoria, 2019

Sources of information	Number of responses*									
	Rainfall forecast	Thunder -storm warning	Tropical cyclone warning	Wind	Tempe rature	Relative humidity	Leaf wetne ss	Soil moisture condition	Flood warning	La Nina/El Nino advisory
Radio	29	24	25	24	23	10	5	196	20	20
Television	305	299	296	288	292	200	108	247	273	296
Mobile Phone (sms)	26	22	25	20	21	5	1	201	22	15
Newspaper/ Tabloid	0	1	0	0	0	0	0	1	0	1
Extension worker	0	0	0	0	0	0	0	2	2	0
PAGASA station	5	5	3	2	3	1	1	0	2	3
Local beliefs/indig enous knowledge	0	0	0	0	0	0	0	0	0	0
Co-farmer	1	0	0	0	0	0	0	0	0	0
SARAI services	0	0	0	0	0	0	0	0	0	0
Others, specify	1	2	1	1	1	14	15	14	4	1

Note: *multiple response
Source: Household Survey, 2019, Victoria, Oriental Mindoro

Majority of the framers agreed that all information are helpful and useful to them hence, the most important information to their farm operations include rainfall, tropical cyclone, La Nina and El Nino, flood warning, temperature and winds, others such as relative humidity, soil moisture and leaf wetness are of less important to them. On the other hand, most of the farmers do not receive information on the soil moisture, leaf wetness and relative humidity, thus, this information usually not being used in farm operations. There are some farmers who do not receive information on flood warnings. 50 to 60% of the total farmers said that the information they receive are reliable while 20-30% said that the information they received are somewhat reliable, thus, the information is slightly reliable. Farmers do not have access to other services that can provide them weather and climate information, that’s why they seldom or even not use it. Hence, very few of them agreed to have PAGASA as the source of the climate and weather information. Most of the farmers or 271 farmers share the information with other farmers. According to many of the farmers, La Niña and El Niño have the earliest forecast, at least 20 days before the occurrence of such phenomenon they are already informed while 3 days before the typhoon hit the land the information has already reached their locality. The response shows that they are already informed at least 1 day ahead before the actual occurrence of the climate and weather.

Utilization, Importance and Influence of Climate and Weather Information on Farming Decision and Planning

Utilization

After receiving information from television, 83% of the total farmers change their timing in fertilization, 79% change in harvest schedule and 78% change their timing in pesticide application. These are the common farm operations that they believe need to change according to the forecasts. While some farmers who received information from mobile and radio also do the same change in timing (Figure 3).

Importance

Farmers were asked how important the attributes (lead time, accuracy, frequency, and reliability) are of weather and climate forecast as well as the long-term climate projection to farming decisions. Most of the farmers said all the attributes are very important to them. 51 to 60% agreed that all the attributes on weather and seasonal climate forecast and long-term climate projection are very important to them. For the lead time - weather and climate information must be given ahead of time for the farmers to prepare possible hazard that the climate or weather may pose to farm operations, for the accuracy – how exact or precise is the given information such as forecast on the occurrence of heavy rain, or the upcoming longer dry spell, for the frequency - how many times the farmers wish to hear about the weather forecast per day, seasonal climate forecast per month and long-term climate projection per year and for the reliability – how true is the forecast, what is the percentage that the farmers' decision can depend on the given forecast.

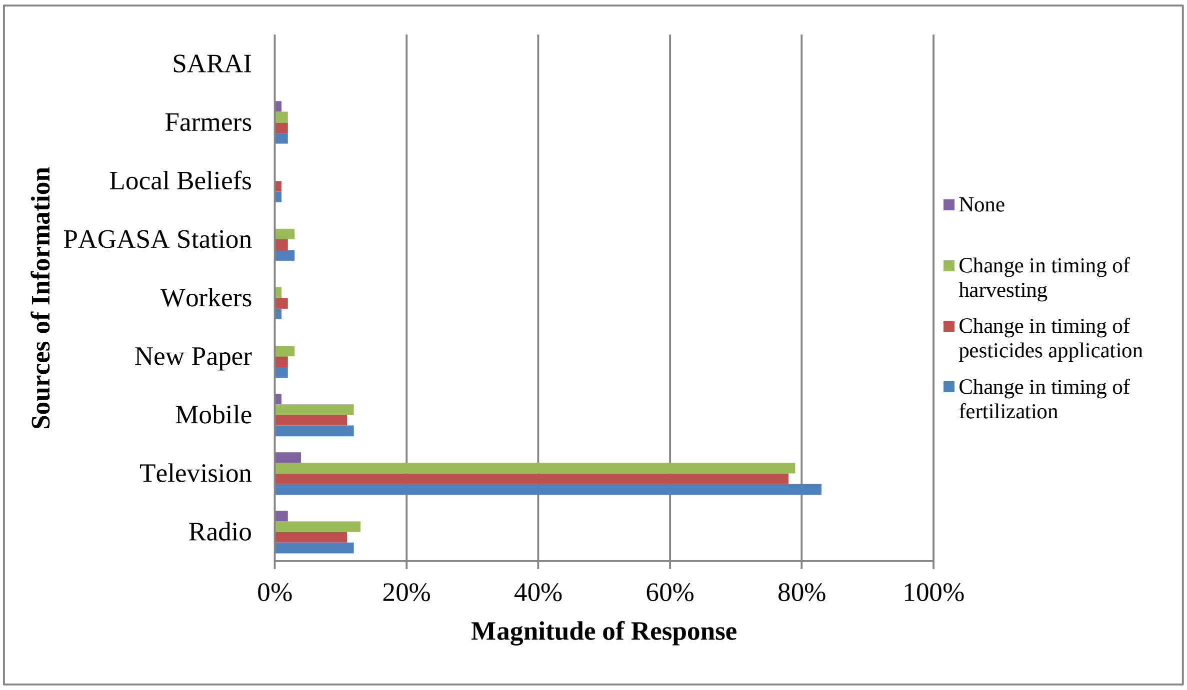

Figure 3. Farming decisions made after receiving weather information, Victoria, Oriental Mindoro, 2019

Farmers appreciate those attributes of climate and weather forecasts as a very important tool to get an assurance that relying on the information given will give them peace of mind in protecting their farm and attain a higher yield and income. On the lead time, 97% of the total farmers preferred to be informed 1 to 3 days before the actual occurrence of the weather and climate forecast and the long-term climate projection while very few agreed that the forecast must be 4-6 days before the actual occurrence. On the accuracy, 61 to 64% of the total farmers preferred that the weather and climate forecast must have 91-100 percent accuracy, while 34-35% agreed 71-90% is tolerable for them. On the frequency, 57% of the total farmers said preferred weather forecast to have a frequency of 1 to 2 per day while 37% preferred to have 3 to 4 per day. While 67% of the total farmers agreed that seasonal climate forecast must have a frequency of at least 1 to 9 per month and 45% of the total farmers agreed that the long-term climate projection must have a frequency of 1 to 9 per year.

Influence

Farmers were asked how weather and climate change affect farmers' decision making in the following type of decisions: operational decisions, strategic and tactical decisions. The operational decision is influenced by rainfall, temperature, flood, and drought. The tactical decision is influenced by El Niño, La Niña, flood, and drought. The strategic decision is influenced by long-term temperature, long-term rainfall, and long-term tropical cyclone.

Operational Decision

On the operational decision, the result shows that out of 324 farmers, 296 of these agreed that the fertilizer application is influenced by the occurrence of rainfall, 251 agreed it is influenced by temperature, 254 says it is affected by flood and 294 believed that fertilizer application is affected by drought. On the other hand, 294 farmers agreed that the farmers decision on pesticide application is influenced by rainfall, 287 farmers believe that it is affected by drought, 252 farmers believed their decision is affected by the occurrence of flood and 245 farmers agreed that pesticide application is influenced by temperature. While on irrigation decisions, 289 farmers agreed that their irrigation decision is influenced by drought, 262 farmers said it is influenced by flood, 252 farmers believe their irrigation decision is affected by rainfall and 233 farmers said that it is influenced by the temperature. On crop protection decisions, 283 farmers agreed that their decision on crop protection operation is influenced by drought, 252 farmers believe their decision is influenced by rainfall, 247 farmers agreed it is influenced by flood and 233 farmers believed crop protection decision is affected by temperature. On harvest decision, 292 farmers believe that their harvest decision is influenced by occurrence of rainfall, 283 farmers agreed it is influenced by drought, 252 farmers agreed it is influenced by flood and 233 farmers believe that harvest decision is influenced by temperature. While 288 farmers agreed that their storage decision is influenced by rainfall, 280 farmers believed it is influenced by drought, 256 agreed it is influenced by temperature and 250 farmers said their storage decision is affected by flood.

Tactical Decision

On the tactical decision, out of 324 respondents in Victoria, 318 of these agreed that their crop choice on the next cropping season is influenced by the occurrence of El Niño, 314 farmers believed it is influenced by drought, 310 farmers agreed the decision is affected by La Niña and 301 farmers believed crop choice is affected by the occurrence of flood. While 323 farmers believed that their planting schedule is influenced by El Niño, 320 respondents agreed it is influenced by drought, 308 farmers believed planting schedule is affected by La Niña and 298 farmers said it is affected by flood. On the other hand, 313 farmers agreed that the allocation of their financial resources for the next cropping season is influenced by El Niño, 310 farmers by drought, 308 farmers by La Niña and 297 farmers by flood. While 311 farmers believed that drought influenced their decision on land allocation for the next cropping season, 310 farmers agreed it is influenced by El Niño, 304 farmers agreed it is influenced by La Niña and 296 farmers believed it is influenced by the occurrence of flood. While these weather and climate indicators also tactically influenced the farmers' decision in looking for off farm work. Out of 324 respondents, 226 farmers agreed that their decision on looking for off farm work is influenced by El Niño, 220 agreed that it is influenced by drought, 210 farmers believed it is influenced by La Niña and 209 farmers agreed that the decision is influenced by flood.

Strategic Decision

On the strategic decision, majority of the farmers or out of 324 respondents, 296 of these agreed that their land use decision is influenced by the long-term change in temperature pattern, 292 farmers agreed that it is influenced by the long-term change in rainfall pattern and then 293 farmers believed their decision is influenced by the long-term change in tropical cyclone pattern. While 293 farmers said that their decision pertaining to the use of perennial or annual crops is influenced by the long-term temperature pattern, 292 farmers said it is influenced by the long-term rainfall pattern and 291 farmers believed it is influenced by the long-term tropical cyclone pattern. Lastly, 246 farmers agreed that their decision to change the combination of mixed crops and livestock farming is influenced by the long-term rainfall and typhoon pattern and 243 farmers believed it is influenced by the long-term temperature pattern.

Farmers' Preference on Weather and Climate Information Source, Lead Time, Accuracy, and Frequency

Majority of the farmers preferred the television to be the media platform delivering climate and weather information. This is because many the farmers own television and it is the easiest way of acquiring information from local and national news. On the other hand, the preferred lead time for weather forecast of the 310 respondents is 1-3 days, while for the seasonal forecast, 303 farmers preferred also to have 1-3 months lead time and 308 farmers preferred long-term climate projection to have a lead time of 1 to 3 years. While the preferred accuracy of many farmers for weather forecast (206 farmers), seasonal climate forecast (199 farmers) and long-term climate projection (200 farmers) is 91-100%. The preferred frequency of the farmers for weather forecast is 1 to 2 times per day, for the seasonal forecast is 1 to 9 times per month and for the long-term climate projection is 1 to 9 times per year. According to the farmers, La Niña and El Niño have the earliest forecast; they are informed at least 20 days before the occurrence of such a phenomenon. Then, 3 days before the typhoon hit the land they were already informed and notified by the local disaster risk reduction and management office for the potential threat of the typhoon, and they were provided with necessary preparedness measures. Responses showed that the farmers were already informed at least one (1) day ahead before the actual occurrence of the climate and weather events.

Farmer's Information Needs and the Gaps on Information Dissemination

Information needs

The results show that 55% of the total farmers said that they do not need more information because important information such as rainfall, temperature, thunderstorms, tropical cyclones, and El Nino/La Nina is given through television, radio, or cell phone. Except for the soil moisture and leaf wetness, there are 24-31% who said they also need those but not given to them. While 4-6% of the total farmers said they need wind and flood warning, hence, not given to them and very few farmers at least 1-2% farmers said that information on rainfall, temperature, thunderstorms, tropical cyclones, and El Nino/La Nina was not given to them.. Hence, during the FGD, we asked the farmers if they accessed the website of PAGASA/bagong.pagasa to check and use climate information for agriculture. Many of them do not have access or time to browse to the internet to use the climate information for agriculture such as farm weather forecast, ten-day regional agri-weather information, and monthly Philippine-climatic review outlook, nor do they browse the daily weather forecast intentionally for agriculture operations. The climate information for agriculture of PAGASA is new to them and has not been introduced as a guide in farm decision making (Figure 4).

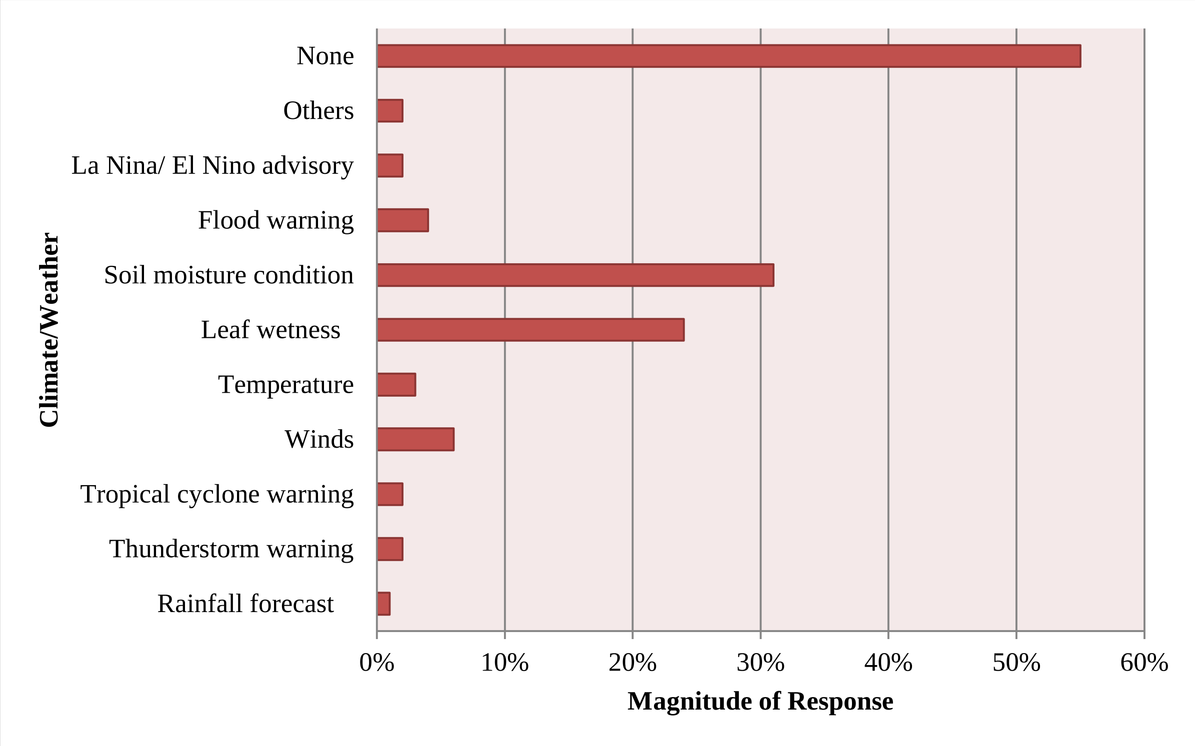

Figure 4. Information needed but not delivered by source, Victoria, Oriental Mindoro, 2019

Farmers reiterate that there is a wave of need for the climate and weather information for agriculture that PAGASA is providing. Information on the onset of the rainy season and the extent and duration of rainfall that can cause floods are very important. Farmers admit they need technology that can help protect their farms from the risks posed by climate and weather events. Thus, farmers expressed their willingness to participate actively in programs that can secure rice production and improve productivity.

Gaps on knowledge, access, and use of weather and climate information

During the focus group discussion, we validate the result from the household interview. We asked the farmers how important the weather and climate forecast in their farm operations are. Farmers replied by telling their experiences, that nowadays the impact of the unpredictable weather and climate is getting harder and worse. They compared the situation then and now, they observed that the Indigenous knowledge or the traditional weather and climate pattern are changing and by this time not dependable. There are months they expect supposed to be the onset of the rainy season, hence, still dry and the months that are supposed to be wet still dry. The changing climatic condition affects their usual planting schedule, and they find it hard to cope. Farmers recognized that accurate and reliable climate and weather information which will help them cope with the changing climatic condition must be introduced to them. Heavy rainfall adversely affects rice production in Victoria since most of the farmers are availing the irrigation services provided by the National Irrigation Administration (NIA). Hence, at this point of time, majority of them do not consider climate and weather information in farm decision making. Nevertheless, farmers recognize that the use of accurate weather and climate information could help and improve farm level decision making. They appeal that someone could provide and capacitate them in utilizing the climate and weather forecasting as they already perceive that the impact of weather-related hazards and climate change is getting worse and coping with it is hard (FGD, 2020). Farmers said television is the major source of information, usually forecast for tropical cyclone warnings, occurrence of heavy rainfall and daily weather conditions. Hence, climate information for agriculture is not delivered or introduced to them. Farmers do not have an idea on the use of the farm weather forecast and the 10-day agri-weather information provided by "payong" PAGASA. Moreover, important information on onset of the rainy season and the extent and duration of rainfall that will cause flood are not delivered to them. Farmers said none of them are capacitated in using climate information for agriculture. Many of the farmers do not consider forecasts in farm decision making, which may suggest that farmers in Victoria are risk-takers. The sense in that case is that farmers are risk takers because they do not have any knowledge about weather forecasts nor have any access to climate information that would change their farming pattern at least for the time that there would be extreme weather and climate conditions like typhoons, El Nino or La Nina. In the absence of such weather information, they gamble resulting in uncertain gains or intermittent losses. Farmers have to operate according to the typical farm operations schedule. Nevertheless, farmers accept climate and weather events greatly influence decision making at the farm level. The introduction of the use of weather and climate forecast in farm activities is new to them. Hence, farmers agree, they need to grasp the new technology and as much as possible capacitate them to utilize climate and weather information in farm decision making.

Summary, Conclusion, and Recommendation

The study assessed the use and importance of weather and climate information in farm decision making in the municipality Victoria, Oriental Mindoro, Philippines. The study was initiated with the purpose of improving the utilization of climate and weather forecasts in farm operations decisions. A house-to-house interview using a structured questionnaire was employed to gather relevant data and sufficed with focus group discussion. Results show that most of the farmers in Victoria are aware of climate change. Farmers perceived that climate change is adversely affecting rice production in the municipality particularly the occurrence of more intense and heavy rainfall. The farmers experienced a late onset of the rainy season and longer occurrence of the dry period. Hence, farmers give emphasis to heavy rainfall that result in flooding and flash floods. This type of hazard brings more damage to crops and worse there were times that they harvest no more. The level of awareness of farmers on climate change carried them to understand that the impact is hard to cope without the support of science-based information as their traditional knowledge is not reliable this time. Farmers appreciate that the lead time, accuracy, frequency and reliability of weather and climate forecast are very important to farm decision making. The weather and seasonal climate forecast, and the long-term climate projection greatly influence different farm operations from the choice of rice variety, seed sowing, fertilizer and pesticide application, water management, harvest, and storage, and selling decisions. This study supports the evidence that the farmers need science-based knowledge such as reliable weather and climate forecast as well as other PAGASA agricultural related climate services. Qualitative research like this is the first step to discover the needs of the farmers and in providing accurate weather and climate predictions to support farming decisions. The paper further concludes that the awareness of the farmers to the impacts of climate change, in addition to their actual experiences, is instrumental for farmers to realize the importance of a science-based climate and weather information as a tool in farm decision making. Realizing that today, traditional knowledge is not any more reliable; farmers admit that new technology is needed. The technology that can provide accurate, reliable, and advanced weather and climate information for farm decisions is highly recognized by the farmers. These technologies refer to the Climate Information for Agriculture and other climate and weather forecasts from PAGASA in which the Agricultural Extension Workers may introduce to farmers. Hence, most of the farmers are not aware of the Climate Information for Agriculture. More observations need to be done to thoroughly discover the advancement of said technology and provide more improvements at the farm level. Literatures clearly recommend the use of climate and weather information for enhanced farm decision making. Thus, to improve the use of weather and climate forecast in Victoria, Oriental Mindoro, the study recommends the following policies and programs:

Introduction of the Climate Information for Agriculture through the initiative of the Local Government Unit (LGU) under the management of the Municipal Agriculture Office with a designated Agricultural Extension Worker (AEW) specializing on the use of weather and climate information for farm decisions.

1. Designate extension worker to specifically work on disseminating PAGASA weather and climate information to the end users. PAGASA and the local government unit should collaborate to effectively disseminate the technology to the farmers and ensure that the information reaches the farmers, and the services are established in a way that stimulates feed-back from farmers.
2. Provide other means of information dissemination other than relying on television, AEW should conduct an information and education initiative to effectively relay the information to the farmers.
3. The LGU must give attention and prioritize the program on the use of science-based climate and weather information as critical revenue for rice farming decisions.
4. Organize farmers association with collective and participative efforts in the utilization of climate and weather information as a tool for enhanced farm decisions.
5. LGU must initiate continuous collaborative efforts with the national government, non-government organizations, academes, private sectors, and people's organizations to create a venue and strengthen the use of weather and climate information in agriculture operations.
6. As much as possible, develop or establish an Automatic Weather Station that can provide location specific weather information and create a local climate prediction.
7. Capacitate AEWs on the use of climate and weather forecasts using the PAGASA products and reecho to the farmers.
8. Conduct participatory approach in planning for the use of climate information for farm decision making.
9. Provide and disseminate climate information for agriculture in Layman's terms.
10. Continuous research on the advancement of science-based weather and climate information as an effective tool in farming decisions.

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Conflict of Interest

The author ensures that there is no conflict of interest in this piece of academic research.

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