APRIL 2020

DISCUSSION PAPER SERIES NO. 2020-14

Barriers to Application of Weather and Climate Information in Smallholder Vegetable Farming in Benguet

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April 2020

Abstract

Benguet province's comparative advantage in the cultivation of high value crops such as cabbage, carrots and potatoes are evident in the high volume of production experienced year on year. A reason for this is the province's favorable weather and climate; however, climate change may threaten the stability of the mountain farming systems in the coming years without proper measures for adaptation. This paper aims to understand the current barriers to the access and use of weather and climate information in agricultural decision making, as a means to cope with the changing climate. It was found that while farmers see the value of using weather and climate information, there is a lack of localized weather and climate information applicable to the microclimate of Benguet. The provision of information must also be supported with other interventions, such as access to low cost credit, to provide the other lacking resources farmers need to enact the optimal decision alternative.

Keywords: weather and climate information, high value crops, smallholder farming, agriculture, decision analysis

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Barriers to application of weather and climate information in smallholder vegetable farming in Benguet[1]

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1. Introduction

Climate change can have significant effect on the agricultural production of small-holder farmers. The Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA) reported that there is an increasing trend in the annual and seasonal rainfall in the country and that these trends are associated with extreme rainfall events. During the past 65 years (1951-2015), the number of tropical cyclones has decreased slightly but this has been accompanied by a small increase in the frequency of strong tropical cyclones. Moreover, the observed temperature in the country is warming at an average rate of 0.1 degree Celsius per decade and climate projections suggest continuous warming in the future. These changes, such as highly variable rainfall patterns and distribution, and increasing temperatures, have introduced new aspects and vulnerabilities into agricultural production. By 2050, it is estimated that climate change and variability will cost the Philippines approximately PHP 26 billion annually[3].

Weather and climate information can help farmers enact risk reduction measures against the adverse impact of climate variability on agricultural production. Advances in technology have improved the quality and increased the variety of weather and climate forecasts. It has also boosted dissemination as television, radio and currently the internet and mobile phones can provide information faster to more people. However, provision of weather and climate information do not guarantee its uptake. The quality of the information on aspects such as reliability, accuracy and timeliness affect usability of the forecast. On the user's side, the views and proficiency of the user and the contexts, decisions and resources they face affect utilization of weather and climate information.

This report explores the sources of weather and climate information among smallholder farmers in Benguet, the use of such information in their farm management operations and lastly the barriers to access and utilization of weather and climate information in decisions.

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[1] This paper is part of the preliminary output for the project, "Action ready climate knowledge to improve disaster risk management for small holder farmers in the Philippines", funded by the Australian Centre for International Agricultural Research (ACIAR). This project is a partnership among the following institutions—South Australian Research and Development Institute, Charles Sturt University, Department of Science and Technology – Philippine Atmospheric, Geophysical, and Astronomical Services Administration, Philippine Institute for Development Studies (PIDS), University of Philippines Los Baños, Department of Agriculture – Agricultural Training Institute, and Benguet State University.

[2] Senior Research Fellow, former Supervising Research Specialist, former Research Analyst, Supervising Research Specialist, Research Analyst, and President, respectively, at PIDS.

[3] https://cgspace.cgiar.org/bitstream/handle/10568/82572/CRA_Profile_Philippines.pdf

1.1. Background of the Project

This is part of the project titled "Action ready climate knowledge to improve disaster risk management for smallholder farmers in the Philippines". It aims to improve the value of information flows from PAGASA and key decision makers involved in managing weather and climate risk of smallholder farmers.

The project's objectives are

1. Understand the disaster risk reduction and climate change adaptation for smallholder farmers in the case study regions
2. Analyze the potential and realized value of weather and climate forecasts in the context of decision-making
3. Develop pilot communication material and scale-up the findings in local government units and community-based organizations This activity supports objectives 1 and 2. Beyond smallholder farmers, agricultural extension officers and municipal agriculturists are the other focus decision makers of the project.

2. Vegetable Production of Benguet

Benguet is chosen as the study site because it is a major producer of high value crops in the Philippines with a well-connected value chain. It is located in the southernmost part of the Cordillera Administrative Region (CAR) and politically divided into 13 municipalities and 140 barangays. In general, the province is considered as high elevation wherein the elevation ranges from 200 meters to 2,792 meters. The province has Type I climate classification by the Corona's Systems of Classification with two distinct pronounced seasons, wet from May to October and dry during the rest of the year. Temperature ranges from a minimum of 8.6 degrees Celsius in January to a maximum of 26.0 degrees Celsius in April.

The temperate climate makes the province suitable in producing high value vegetable crops. In 2016, CAR accounted for 82.9 percent of the total national production of cabbage, carrots and white potato, producing 253,404 metric tons of the three crops out of the national level of 305,850 metric tons (see Table 1). Benguet has the highest production among the provinces in CAR.[4]

Table 1. Volume of production of cabbage, carrots and white potato by region, Philippines, 2016

Region	Production (metric tons)	% Share from Total Production
CAR	253,404	82.9
Ilocos Region	3,265	1.1
Cagayan Valley	2,647	0.9
Central Luzon	-	-
CALABARZON	726	0.2
MIMAROPA	35	0.0
Bicol Region	132	0.0

[4] Philippine Statistics Authority, http://rssocar.psa.gov.ph/agriculture-releases/2016-crop-production-cabbage-carrot-and-potato (accessed November 2018)

Western Visayas	407	0.1
Eastern Visayas	7,521	2.5
Central Visayas	149	0.0
Zamboanga Peninsula	1,134	0.4
Northern Mindanao	13,629	4.5
Davao Region	15,297	5.0
SOCCSKSARGEN	2,509	0.8
CARAGA	3	0.0
ARMM	462	0.2
Negros Island Region	4,531	1.5
Total	305,850	100.0

Note: details may not add up to total due to rounding
Source: Philippine Statistics Authority

The total volume of cabbage production was 123,080 metric tons in 2016. CAR accounts for 77 percent or 94,728 metric tons and followed by Northern Mindanao with 5.3 percent or 6,524 metric tons (see Table 2). Among the provinces in CAR, Benguet province produces 86.3 percent share of the region's total production which is equivalent to 81,778 metric tons.

Table 2. Volume of production of cabbage by region, 2016

Region	Production (metric tons)	% Share from Total Production
CAR	94,728	77.0
Ilocos Region	3,265	2.7
Cagayan Valley	1,612	1.3
Central Luzon	-	-
CALABARZON	696	0.6
MIMAROPA	33	0.0
Bicol Region	114	0.1
Western Visayas	319	0.3
Central Visayas	6,161	5.0
Eastern Visayas	137	0.1
Zamboanga Peninsula	821	0.7
Northern Mindanao	6,524	5.3
Davao Region	4,210	3.4
SOCCSKSARGEN	1,385	1.1
CARAGA	3	0.0
ARMM	462	0.4
Negros Island Region	2,611	2.1
Total	123,080	100.0

Note: details may not add up to total due to rounding
Source: Philippine Statistics Authority

For carrots, the nationwide production was 65,987 metric tons in 2016. CAR's share to total production is 86.9 percent or 58,965 metric tons and followed by Central Visayas with 2.1 percent or 1,361 metric tons (see Table 3). Benguet has the biggest share to production within the CAR region with 92.9 percent or 54,500 metric tons.

Table 3. Volume of production of carrot by region, 2016

Region	Production (metric tons)	% Share from Total Production
CAR	58,695	88.9
Ilocos Region	-	-
Cagayan Valley	575	0.9
Central Luzon	-	-
CALABARZON	30	0.1
MIMAROPA	2	0.0
Bicol Region	18	0.0
Western Visayas	88	0.1
Central Visayas	1,361	2.1
Eastern Visayas	12	0.0
Zamboanga Peninsula	313	0.5
Northern Mindanao	1,227	1.9
Davao Region	1,241	1.9
SOCCSKSARGEN	512	0.8
CARAGA	-	-
ARMM	-	-
Negros Island Region	1,914	2.9
Total	65,987	100.0

Note: details may not add up to total due to rounding
Source: Philippine Statistics Authority

Lastly, for white potato, the total production was 116,783 metric tons in 2016. CAR accounts for 85.6 percent or 99,981 metric tons and followed by Davao Region with 8.4 percent or 9,846 metric tons (see Table 4). Similar to cabbage and carrot production, Benguet has the highest share in the CAR region, producing 88,771 metric tons.

Table 4. Volume of production of white potato by region, 2016

Region	Production (metric tons)	% Share from Total Production
CAR	99,981	85.6
Ilocos Region	-	-
Cagayan Valley	460	0.4
Central Luzon	-	-
CALABARZON	-	-
MIMAROPA	-	-
Bicol Region	-	-
Western Visayas	-	-
Central Visayas	-	-
Eastern Visayas	-	-
Zamboanga Peninsula	-	-
Northern Mindanao	5,879	5.0
Davao Region	9,846	8.4
SOCCSKSARGEN	612	0.5
CARAGA	-	-
ARMM	-	-
Negros Island Region	5	0

Total	116,783	100.0

Note: details may not add up to total due to rounding
Source: Philippine Statistics Authority

3. Data Collection

Benguet was selected as the case study site because it is a major producer of vegetables and with a well-connected value chain. Farmers sell their produce in trading centers such as the La Trinidad Vegetable Trading Post and Benguet Agri-Pinoy Trading Center.

The findings presented in this report are from a series of semi-structured interviews among smallholder farmers, traders and agricultural extension workers. The report also incorporates discussion from a national workshop on barriers and opportunities on access and utilization of weather and climate information organized by PAGASA and a provincial workshop in Benguet attended by agricultural extension workers, municipal agriculturists and municipal disaster risk reduction officers in 2019. Lastly, a household survey of vegetable and cut flower farmers in Atok and La Trinidad was conducted in May and August 2018.

3.1 Focus group discussions

The farmer participants in the discussions are from a non-random sample. The local government, through the Atok Municipal Agricultural Office, and Benguet State University provided support in finding farmer respondents who were willing to participate in focus group discussion and share their experiences and farm operations to the project team and fellow farmers. Relative to the project team, these agencies are better suited in finding farmer respondents because of their local knowledge of the municipality and their experience working directly with small-holder farmers. In addition to the farmer respondents, the project team have also conducted separate interviews with the municipal agriculturist and technicians, representatives from trading associations and officials from the La Trinidad Vegetable Trading Post, and a representative from the Provincial Agricultural Office of Benguet.

The farmer respondents are composed of 3 males and 3 females. Table 5 provides the characteristics of the respondents. The male respondents on average are older, have longer farming experience and have a bigger farm size compared to the female respondents. All the farmers practice crop rotation and produce vegetables such as cabbage, carrots, potatoes and radish. Two of them also plant cut flowers in addition to vegetables.

Table 5. Focus group respondent characteristics

	Male (n=3)	Female (n=3)	Both (n=6)
Average age	55.67	44.00	49.83
Average years of farming	21.00	15.00	18.00
Average farm size (hectares)	1.78	0.38	1.08
Average number of parcels	1.00	1.33	1.17

The interview guide is designed to elicit information on the farmers' experience and views on climate variability and its impact on their agricultural production and the household, to understand their perception, awareness and use of climate information, and lastly to identify key farm decisions that are influenced by their use of climate information. They also did an exercise wherein they have to provide potential yield, prices or management decisions under different climactic states or given a type of weather and climate information.

There are limitations in the use of interviews and exercises. First, information from reported behavior may be different from actual behavior. Nevertheless, because of the presence of other participants, focus groups are likely to produce less exaggerated responses. However, it is difficult and tedious to collect, record and verify the information. Second, it is problematic to generalize the results taken from a small and non-random sample. Given these limitations, there is still value in using interviews and simulation exercises. The methodology allows farmers and researchers to experiment with a range of climactic conditions and farm decisions in a cost-effective manner relative to conducting long-term empirical research which may also be restricted by financial, political and institutional factors.

3.2 Household survey

In addition to the focus group discussions, a household survey of smallholder farmers producing carrots, cabbage, potatoes and cutflowers in Atok and La Trinidad was conducted. The sampling frame is based on the Registry System for Basic Sectors in Agriculture, a national listing of farmers, farm workers and fisher folk. A random sample of cabbage, carrots, potato and cut flower farmers in Atok, Benguet was taken from the national listing and further validated with the local government since they have more information on the status of the farmers living in their barangay.

Prior to the survey, the project team and field interviewers conducted pre-test of the questionnaires to farmers not included in the survey. Field interviewer training was also held to familiarize the field interviewers with the survey instrument and the use of a tablet. The hired field interviewers are licensed agriculturists living in Benguet and have prior experience in conducting farmer household survey. Moreover, a faculty from Benguet State University provided support in the daily operation and management of the interviews during the survey period. The questionnaire covers, among others, disasters experienced by the household, credit

practices, land use, production by climactic condition, farmers' understanding of climate change, sources of climate and weather information, farmer decisions that are influenced by weather and climate information, and adaptation choices to climate change. All the interviews were completed in August 2018.

3.3 Workshop on barriers and opportunities on access and use of weather and climate information

In May 2019, PAGASA held a workshop with national stakeholders that aim to identify the factors that hinder the access and use of weather and climate information specifically for small-holder farmers, as well as to gather suggestions that will contribute to improve the delivery and ease of usage of PAGASA information. National government agencies such as the Department of Agriculture, civil society groups and academe attended the workshop. A similar workshop was conducted in La Trinidad, Benguet. Municipal agriculturists, agricultural extension workers, municipal disaster risk reduction officers in the province and academe were the participants.

The PAGASA presentation included their products and services, type of information presented, time aspects in forecasts and area coverage. The presentation aimed to improve the understanding and knowledge of the participants on PAGASA services.

In the workshop proper, the participants formed groups and each member had metacards to record their answers. They had to identify barrier/s against the access and use, opportunities that promote or facilitate access and use, and lastly provide recommendations to overcome the barriers or exploit opportunities for each group of PAGASA product namely warning, weather forecast, seasonal climate forecast and climate change projections. After this, each participant explained his/her answer to the group. At the end of the workshop, a member explained the barriers to access and use, opportunities and recommendations of the assigned PAGASA product to all.

4. Sources of Climate and Weather Information

The Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA) is the lead government agency that provides various weather and climate information. Table 6 lists the types of information produced by PAGASA, the time coverage and issuance of the PAGASA product, and the area of coverage. The information is grouped into warnings, weather forecasts, climate outlooks and advisories and projections. These groups are mainly based on the time covered. Warnings are relatively short term while climate projections cover up to thirty years.

Table 6 List of PAGASA weather and climate information

PAGASA Products	Type of information		Time Covered/ Issuance	Area Covered	Description
Warning	Severe weather bulletins	Alert	12 hrs. /as need arise (11am and 11pm)	Nationwide	Released during events of TC passage over the Philippine Area of Responsibility (PAR)
		Warnings	3 to 6 hrs. / as need arise (6- hourly, but 3-hourly for 24-hour before landfall)		
	Tropical Cyclone Warning for Agriculture		24-hour/as need arise	Nationwide	24-hour Tropical Cyclone Warning Advisories (TCWA) for Agriculture activities
	Tropical cyclone warning for shipping		3 to 6 hours / as need arise	*Coastal areas*	*Warnings for major shipping routes during events of TC passage over PAR*
	Weather advisory		*Once a day (11am during heavy rainfall event)*	Nationwide	Weather advisory issued during heavy rainfall event
	Gale warning information		*6 to 12 hrs./* as need arise	*Coastal areas*	*Warnings for major shipping areas on events of strong winds*
	Storm Surge Warning		*6hrs/ As need arises*	*Coastal areas*	*Warnings for coastal areas on possible occurrence of storm surge in events of strong winds (e.g. typhoon passage)*
	Rainfall Warning System		*3 – 6 hrs. / As need arises*	*Provincial*	*Special report for selected areas during significant rainfall events*
	Thunderstorm Alert System		*3 – 6 hrs. / As need arises*	*Provincial*	*Special report for selected areas on impending thunderstorm events*
Weather Forecast	Weather Forecasts		Daily / Daily	Nationwide	24-hour public weather forecast for specific region

				(released at 5:00 am and 5:00 pm)
	Regional Weather Forecasts	Daily / Daily	Regional	24-hour public weather forecast (released at 5:00 am and 5:00 pm)
	Farm Weather Forecast and Advisory	Daily / Daily	Nationwide	24-hrs Farm Weather Forecast Advisory (FWFA) Released at 8am
	3-day weekend Agri-weather forecast	3 days/ Once a week	Nationwide	3-day weekend forecast for farm operations
	Shipping Forecasts	*12 hrs. / 2x a day*	*Coastal Areas*	*Contains forecasts for major shipping areas*
Climate Outlooks and Advisories	10-day Forecast	10 days / daily	Municipal	10-day weather outlook for farm operations (Temperature, Rainfall, Total Cloud Cover, Rel. Humidity, Wind) for selected Municipalities
	10-day Probabilistic Forecast	Running 10 days/ Every Thursday	Nationwide	10-day probabilistic forecast of rainfall and temperature for PAGASA Synoptic station
	10-day Agri-weather Information	10 days/Every 10th day (Decadal)	Regional	10- day agri-weather forecast and crop phenology for farm operations per Region
	Monthly Climate Assessment and Outlook Advisories	Monthly/ Monthly	Nationwide	Monthly issuance of observations for the past month and forecast for the next month, includes other weather systems that will likely influence the country
	Seasonal Climate Assessment and Outlook Advisories	6 months/ Every 6 months	Nationwide	6 months issuance of observations for the past six months and forecast for the next six months, includes

				other weather systems that will likely influence the country
	Monthly Regional Forecast Quick Outlook	Monthly/ Monthly	Regional	Monthly issuance of Rainfall forecast and climate outlook per Region.
	Monthly Rainfall Forecast	6 months/ Monthly	Nationwide	Monthly issuance of 6 months deterministic forecast for rainfall
	Monthly Temperature Forecast	6 months/ Monthly	Nationwide	Monthly issuance of 6 months deterministic forecast temperature
	Monthly Probabilistic Forecast	6 months/ Monthly	Nationwide	Monthly issuance of 6 months probabilistic forecast
	Monthly Tropical Cyclone Forecast	Monthly/ Monthly	Nationwide	Forecast number of Tropical Cyclone that will enter/occur in the PAR
	Drought and Dry Spell assessment and forecast	As need arises	Nationwide	Issuance of Drought and Dry observations for the past months and forecast for the next six months particularly during ENSO events
	Press Release	During a significant climate phenomena (I.e., ENSO)	Nationwide	Issued for Onset and Termination of: *Northeast Monsoon (Amihan) *Southwest Monsoon (Habagat) *Rainy Season Includes other climate phenomena (i.e., ENSO)
	El Niño/ La Niña Advisories, El Niño/ La Niña Watch	During occurrence ENSO phenomena	Nationwide	El Niño Southern Oscillation (ENSO) status; “Advisories” speak of the current ENSO phase whereas “watch” refers to the forecast of ENSO phase based on

				PAGASA ENSO alert system
	Monthly Agro-climatic Review and outlook	Monthly	Nationwide	Review of the previous month and outlook of the following month farm advisory and crop stages
	Impact Assessment for Agriculture	Monthly	Regional	Assessment of agricultural performance based on the Generalized Monsoon Indices (GMI) and the Yield Mean Indices (YMI) and other relevant extreme weather incidents (e.g. heavy rainfall, drought, typhoon passage)
Climate Projections	Climate projections for the Philippines	Mid-21st Century (2036-2065), Late 21st Century (2070-2099)	Nationwide; per province	Climate projections for the Philippines by province for temperature and precipitation based from all available downscaled climate change data that were simulated under three scenarios; A1B (Socioeconomic driven scenarios), RCP 4.5 and RCP 8.5 (Emission-driven scenarios); Representative Concentration Pathways (RCP)

Source: Philippine Atmospheric, Geophysical and Astronomical Services Administration

This weather and climate information is available in the PAGASA website and is distributed through various channels particularly via television, radio, social media and the internet. There are also initiatives from PAGASA to make weather and climate information more accessible and user-friendly to the public in general. In 2016, PAGASA launched a new mobile application named "DOST-PAGASA". The mobile application contains weather and climate information such as weather bulletin, flood information, tropical cyclone warning and rainfall

and thunderstorm warnings[5]. The state weather bureau also has another mobile application named "Payong PAGASA" which was launched in 2018. It features information on daily monitoring of rainfall and temperature, monthly climate assessment and outlook, farm weather forecasts and advisories, 10-day regional agri-weather information and a 10-day weather outlook, among others.

PAGASA has also developed and used various warning systems that aim to make it easier for the public to understand climate and weather information and possible impacts[6]. The country is prone to typhoons because of its geographic location. These typhoons carry heavy rainfall and strong winds that are destructive to crops, properties and more importantly human life. Hence, delivery of typhoon forecasts that are easy to understand are important. PAGASA delivers tropical cyclone warnings using signal numbers from 1 to 5. Signal 1 informs the public to expect the impact of 30-60 kph winds in 36 hours and that it may cause no damage to very light damage. As the signal numbers increase, the expected wind strength and expected damage also increases. A signal number 5 means very strong winds of more than 220 kph over at least 12 hours and it may cause very heavy damage to widespread damage. A description of possible damages to structure and vegetation are also provided. Another example is the use of color-coded Rainfall Warnings. A yellow warning means 7.5-15 mm rain observed in 1 hour and expected to continue over the next 2 hours. In addition to the amount of rainfall, the advisory also informs the public whether the amount of rainfall would be expected to cause flooding. A yellow rainfall warning advises the public of possible flooding in low-lying areas. Next is an orange warning and the highest is the red advisory wherein the public located in low-lying areas is advised to evacuate because of expected severe flooding. The use of signal numbers and color-coded warnings make it easier for the public to understand and recall the forecasts. Moreover, they have created simplified information and educational materials about weather events such as tropical cyclone warnings, information on flood, La Nina and El Nino and rainfall warnings, that features their mascot aptly named "Ella the Umbrella"[7].

Understanding the processes at the farmer level according to how they collect, interpret and use weather and climate information and how they relate this to their agricultural production decisions is useful. It identifies how the information influence the farmer's crop choice and at the same time recognize the limit or challenges in using weather and climate information in their decisions.

First, do farmers themselves recognize climate change and how is it manifested to them. All of the farmer respondents agree that there has been changes in the weather patterns in their area in the past 10 years, particularly on temperature, rainfall and the occurrence of frost. During the summer months, the temperature is reported to be significantly warmer. They have also observed changes in the occurrence of frost. For instance, frost used to occur in Paoay, Atok but it seems that the temperature has increased in the area through the years. The farmers have

5 https://www.jica.go.jp/philippine/english/office/topics/news/160615.html
6 http://bagong.pagasa.dost.gov.ph/learnings/legend
7 https://www1.pagasa.dost.gov.ph/index.php/18-publication/2714-information-education-and-communication-materials

also shared that it used to be possible to store fresh meat on top of a tree for 6 months but this not possible anymore because of fewer trees and warmer temperature.

The onset, amount and volume of rainfall are also identified as different from what they have experienced in the past decades. Wet and dry seasons do not seem as defined because rainfall is present throughout the year. They observe more typhoons happening in a year, currently at one to two typhoons annually when it has used to be about one typhoon in every three years. In addition to the higher frequency of typhoons, there are observed changes in their onset. Currently, typhoons also arrive in October when it has used to be in July to August.

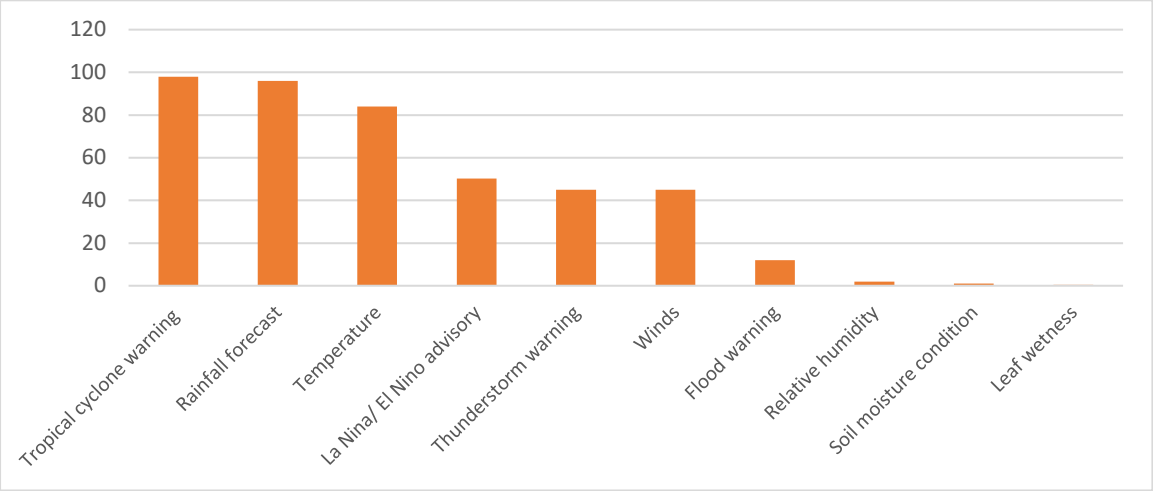
The household survey collected information on the level of the farmer household's awareness of climate change. The majority of the respondents (90.94 percent) have noticed significant changes in temperatures in the past 30 years and this change is characterized by hotter than usual temperature in the dry season (84.42%). These results agree with the observations of the farmers in the interviews. Most of the respondents (91.34 percent) also noticed long-term changes related to rainfall in the past 30 years. These changes are described as earlier than usual onset of rainfall, more frequent rainfall and higher than usual amount of rainfall. Table 7 shows the changes in rainfall as described by the respondents.

Table 7. Changes in rainfall

	Frequency	Percent
Onset earlier than usual	135	58.19
Delayed onset	20	8.62
Amount lower than usual	1	0.43
Amount higher than usual	22	9.48
More frequent rainfall	36	15.52
Less frequent rainfall	2	0.86
Longer duration of rainfall	12	5.17
Others	4	1.72
Total	232	100.00

The major sources of climate and weather information are radio and television, a result also supported in the farmer household survey. Warnings from the disaster risk reduction officer sent via sms, internet and co-farmers are also mentioned as other sources but none have reported to get information directly from PAGASA. This result shows that farmers receive second hand climate and weather information and that they do not rely on a single source of information. Annual seasonal climate forecast and tropical cyclone warning (TCW) are the weather and climate information usually received by the participants, while tropical cyclone warning, rainfall forecast and temperature information are also commonly received by the respondents (see Figure 1).

Figure 1 Type of Weather and Climate Information received by the respondents



In relation to agricultural production, the onset of the rainy and dry season is ranked first by the participants and considered as the most important information needed, followed by the amount of rainfall, onset of the rainy or dry seasons and lastly the estimated number of days of rainfall season. The importance placed by the farmers on information related to rainfall emphasizes their dependence on rainfall as a primary source of irrigation and the sensitivity of their crops to the onset, amount and duration of rainfall.

In general, the climate and weather information received by the participants are rated only as moderately relevant. They have shared that the information they receive seems to not really reflect the conditions in their locality. There are several possible reasons behind this view. First, the farmers acknowledge that climatic conditions of Atok are unique. It has a land area of 22,385.4958 hectares with two-thirds of it having a 40-60 percent slope, which is characterized as hilly to mountainous. Meanwhile, the remaining one-third is 60 percent above slope and is characterized as rugged mountain areas. The municipality is also considered high elevation, wherein the highest elevation in the municipality is 7,400 feet above sea level while the lowest elevation is 600 meters above sea level[8]. Second, the farmers receive second hand information primarily from radio and television. These forecasts are tailored toward the greater audience. As a result, the information is not modified towards the needs of small-holder farmers or specific to the conditions of the municipality, at least. During the discussion, the participants have appealed for an advanced and accurate forecast that addresses the microclimatic condition of their area.

[8] http://www.dilgcar.com/index.php/2015-07-10-07-24-09/municipality-of-atok

5. Use and Limits in the Use of Climate and Weather Forecasts

Climate and weather forecasts act as valuable information that farmers can use in making decisions. Forecasts can be a risk management tool if farmers can use the information such that their decision will allow them to minimize the losses or take advantage of climate variability.

Based on the interviews, the farmers diversify their crops and do not practice mono-cropping. The practice allows them to maintain soil quality and at the same time protect themselves against low prices or low yield. The identified crops are mainly cabbage, potato and carrot which are the main crops in Benguet, though some have also mentioned planting radish. Table *8* lists a summary of weather and climate forecasts and farmer's decisions in response to the forecast.

Table 8 Summary of weather and climate forecast and farmer response

Activity	Forecast	Response
crop choice	drought or below normal rainfall	plant drought tolerant crops such as potatoes or radish
choice of crop variety	dry season	cabbage: scorpio variety
	wet season	cabbage: rareball variety
source of irrigation	drought	use of water delivery services improvised catchment basins
occurrence of frost	no frost forecast yet in Benguet	do not plant in identified frost-occurring areas in the farm; plant crops that can tolerate cool temperatures such as carrots or cabbages use sprinklers in the morning to melt the ice
harvesting	occurrence of typhoon	use rain shields to protect the crop consult with disposer and check if crop is suitable for early harvest

Farmers adjust their choice of crop in response to the seasonal climate forecast. If the forecast warns of a dry season, they choose to focus on drought tolerant crops such as potatoes or radish or crop varieties that thrive in warm temperatures. For example, there are two identified cabbage varieties. The scorpio cabbage variety has better taste but is sensitive to rainfall while the RB cabbage variety is hard and durable. In response to a drought forecast, the farmers will choose to plant Scorpio variety and supplement it with sprinklers to distribute water. If the forecast is wet season, the RB cabbage variety is preferred. Farmers also harvest it earlier at only 3 months compared to the Scorpio variety which is 4 months. Another response to a drought forecast is to buy water in the lowlands and have it delivered to Atok.

Most farms are dependent on rainfall and describes an ideal situation wherein there is light rain in the afternoon every day. Supplemental irrigation is expensive and limited because of the

municipality's location and high elevation. It needs pumps that can cater to high elevation areas. Moreover, the alternative sources of water like rivers also depend on rainfall. Hence, rainfall-related weather and climate information affects many decisions compared to temperature, thunderstorm etc. Extreme rainfall can cause crops to wither and rot. If forecast warns of heavy rainfall, plastic tunnels can be installed to protect the crop. These structures can also help shield the crop against acid rain, pest and fungal infestation. Additionally, it can aid in producing high-quality vegetables as long as it meets the appropriate design criteria such as sufficient ventilation, good light transmission, good air circulation and availability of clean water. If it is acid rain, farmers have to spray the vegetables with potable water to remove acid rain residues.

Frost is a unique occurrence in Atok that has been widely covered by the media. Currently, there is no available frost forecast from PAGASA and farmers have to rely on personal knowledge and experience in predicting the occurrence and location of frost. Farmers have identified, based on personal experience, the specific locations in their farm where frost usually occurs as well as the specific months when it occurs which is from December to February. Thermometers are also installed to help gauge if a frost will occur. There are several ways that a farmer adapts to the occurrence of frost. First, the farmer will not plant in the specific area where frost historically occurs. Second, if the farmer chooses to plant, he will plant crops that grow well on cooler temperatures such as carrots or cabbages. Carrots can tolerate cooler temperatures while the outer leaves of cabbages can be simply removed if covered with ice. Third, sprinklers are used to melt the ice and limit the damages to crops. The farmers have reported that the media exaggerate the negative impacts of frost since they show it destroying a wide area when it is only a small portion of the farm. This is opposite to the destruction caused by strong typhoons or heavy monsoon rains wherein it is possible to have entire fields destroyed.

Lastly, rainfall forecasts also affect harvest decisions. Farmers prefer not to harvest when it is raining as it will hasten spoilage and result to lower quality and price of vegetable. When there is an impending typhoon, the farmer takes into consideration the condition of the crop, particularly if it is suitable for harvest and receive or seek advice from disposers. In return, the disposers also ask their contact buyers if there is demand for the vegetables and the road conditions going to the market before giving a recommendation to the farmer about whether to harvest early.

6. Barriers to Access and Use of Weather and Climate Forecasts

Among the products of PAGASA, the participants are most familiar with warnings. The time of issuance to actual event is shorter than the other products and warnings cover information on typhoons and heavy rainfall, which are of interest in the country and widely covered by the media. On the opposite side, climate projections are the least heard of. Its intangibility and long-term period could have contributed to the public's low interest despite it being useful in preparing plans such as community development plans, comprehensive land use plans and such.

In spite of PAGASA's efforts to improve access and use of weather and climate information such as launching mobile applications, using social media to spread information and developing simplified warning educational materials, there are still opportunities for improvement. First, farmers have limited access to the internet and most are not smartphone users. As a result, they do not have or have limited access to mobile applications and social media. In the survey, radio and TV are the common sources of weather and climate information. These media have a wider reach but the information is not targeted towards agricultural producers or their location. The forecasts are geared toward the general public and the coverage can be regional or provincial and less likely to cover their specific municipality. Hence, some farmers have low trust in forecasts as they are not applicable to their needs or locality and seems different from their own experiences. Second, the general content of PAGASA forecasts is too technical and difficult to understand for a layperson. It is also in English, which most farmers cannot easily comprehend as most farmers in Benguet speak Ilocano, Kankana-ey or Ibaloi.

On the other side, farmers as users of weather and climate information also face constraints in enacting adaptation measures despite of receiving weather and climate information. Delivery of water to drought areas requires additional costs for truck rental, manpower, and fuel as well as an identified source of water. Using sprinklers also incurs expenses like the cost of the equipment (sprinkler), fuel, manpower and source of water. Lastly, protective structures like plastic tunnels needs materials, manpower and skills and management in the daily operation of the farm as not all vegetables grow best under these structures. The costs may eventually be recouped by the farmer but the initial outlay may be too heavy for the farmer to bear. During the discussion, the farmers raised the issue that it is difficult to find labor in their area and have to find manpower in nearby provinces. One of the respondents mentioned finding workers as far away as the Visayas.

The limited resources of the farmer can be addressed by providing access to low-cost credit. However, the respondents complained about the amount of paperwork required, the volume of supporting documents they have to provide, and the time to process and release the loan if they borrow from formal channels such as banks. As a result, the farmers prefer to borrow from informal channels such as disposers. Disposers are easily accessible, convenient and can provide the loan quickly. In terms of loan interest, the common arrangement between farmer and disposer is that the farmer will sell their harvest to the disposer. The disposer will subtract the amount of the loan from the revenue and both parties equally share the marginal profit. In this arrangement, the farmer is at a disadvantage if the price is low or the farmer cannot sell his harvest at a higher price to other disposers or directly to the market. There is also a need to invest in storage or post-processing facilities so that farmers have more time allowance in waiting for a better price for their produce and not having to immediately sell their harvest. Since the farmers are dependent on rainfall, developing effective irrigation systems can minimize the risks faced by the farmer.

There have been efforts from the government to provide trainings to farmers. Such training needs to be tailored to the conditions in Benguet. The farmers have mentioned that the trainings they have received are too general and does not address the conditions that they experience. In

addition, they deem that the trainers have weak credibility because of their limited background in farming and that the training is generally not modified to local conditions. The farmers have felt that they have more knowledge and experience. Improving farmers' understanding of weather and climate information and the uncertainty in forecasts can be included in climate change adaptation or disaster risk reduction programs and trainings provided by the government, among others. Information, education and communication materials targeted to end-users can be developed with concerned agencies that are informative, impact-based and visually appealing.

There is currently no frost forecast from PAGASA so developing a frost forecast is useful for farmers. Also, the farmers raise the need for a localized weather and forecast information. These are challenging to implement because procuring, setting up and maintaining weather and climate forecast equipment are expensive. As reported by PAGASA, there are 60 synoptic PAGASA station in the Philippines, 30 agrometeorological stations, and hundreds of radars. There are also efforts in the agency to develop impact-based forecasting.

Continuous interaction between scientists, the producers of information, and users such as extension workers and farmers are needed to develop weather and climate information that are useful and usable to the users. Research institutions and civil society groups can also help in analyzing weather and climate information and its impact on agriculture. Delivering information through sms or text messages can also assist in disseminating localized weather and climate information as well as farming information directly to the farmers, though this is only a one-way communication.

7. Conclusion

This report explores the constraints faced by the farmer in the use of weather and climate information as a risk management tool in response to climate change. Farmers see the value in using weather and climate information in farm decisions related to crop choice, crop variety and harvesting. However, the farmers need localized weather and climate information that is tailored to the conditions of their locality. The provision of forecast also needs to be supported by other government support programs particularly access to low cost credit so that the farmer can afford the necessary equipment, materials and extra manpower that allows them to reduce the adverse effects of climate variability.

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