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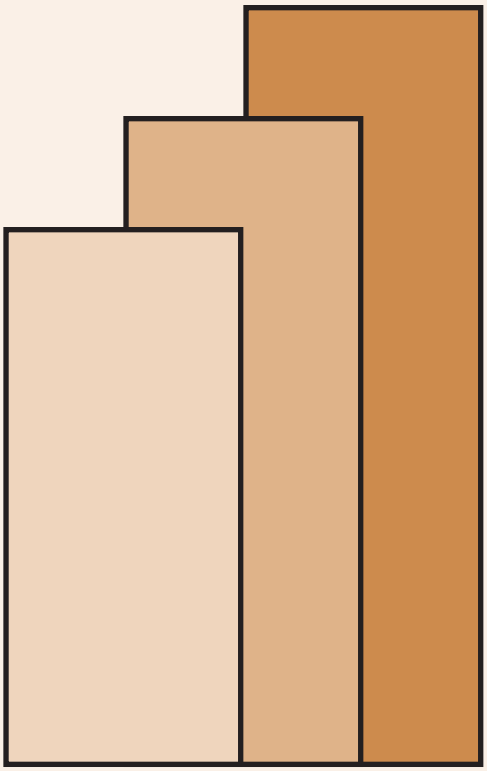

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Celia M. Reyes, Sonny N. Domingo, Adrian D. Agbon, and Ma. Divina C. Olaguera [1]

Abstract

Valuing climate information is now an important discourse in mainstream economic thinking with the development of the von Neumann-Morgenstern utility hypothesis and of the refinement of decision theory under uncertainty. This discourse is important in valuing weather information and climate-related decision support, particularly among agricultural stakeholders. The need to understand better the use and value of climate information and climate sensitive decisions among small holder farmers in selected farmers in Atok and La Trinidad Benguet, Philippines is the aim of this paper. Measures implemented to mitigate the effects La Nina and El Nino are changes in timing of planting and crop shifting and changes in location of crops. Farmers rely to indigenous knowledge when it comes to frost forecasting. On the average, 300 truckers from the trading post transport commodities outside the province on a daily basis. But during typhoons many traders prefer to delay their deliveries. Farmers shared that weather/climate information is major factor taken into consideration in their planning and crop decision making. Climate date for the rainy and or dry season was considered as the most important information they need. Given the unique microclimatic condition of the province, farmers need a localized forecast from PAGASA.

Key words: climate information, climate sensitive decisions, Benguet

1. Introduction

Climate variability and change can adversely affect human and ecological systems. Understanding the adaptation and mitigation capacities of agricultural producers is essential for improving climate-related support to the sector. Farmers must be able to employ a range of strategies and tactics to manage climate-related risks, as well as uncertainties from other sources (Hansen et al., 2004).

Discourses on the von Neumann-Morgenstern utility hypothesis and the decision theory under uncertainty are important in valuing weather information and climate-related decision support, particularly among agricultural stakeholders. Lackstrom et al. (2013) described climate-related decision support as the suite of products, services, and systems designed to inform climate-sensitive decisions. These include climatology, weather forecasts and climate model projections, vulnerability assessments, and the development of technical or process oriented tools. Mitigating climate-related risks in agriculture

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require the delivery and integration of skillful forecasts and apt climate-related information to decision-making processes. Risks can be mitigated only if appropriate information is accurately communicated to and understood by affected groups and individuals. Valuing such would invite appreciation and support from those in the position to help.

The province of Benguet in the autonomous region of cordillera represents a mostly rainfed upland agroecological zone devoted to high-value crop production and trade. Benguet's mountainous terrain and huge dependence to seasonal rainfall make the agricultural stakeholders in the province particularly sensitive to seasonal climatic anomalies. The province would aptly serve as study site when looking into the value of climate-related information particularly for sensitive on-farm and off-farm decisions.

Field visits were conducted in the municipalities of Atok and La Trinidad, Benguet, two leading producers of vegetables and cutflowers in the country. Of particular interest were decision-making processes as they relate to the occurrences of frost in Atok over the past years, and the impact seasonal climatic events on production and market risks. Hydrometeorologic hazards like excessive rainfall and landslides also give impetus to examining the supply chain of produce from Benguet to markets in Metro Manila and other major cities in the Philippines. The researchers conducted series of focus group discussions (FGDs) among farmers representing producers of cut flowers, cabbage, potato and carrots among others; agricultural traders represented by disposers, truckers; and government service providers covering provincial and municipal agriculturists, and agriculture technicians.

The paper is structured as follows: Section 2 presents a brief review of literature on the different methodologies of valuing climate information and weather forecasts; Section 3 presents the study site; Section 4 discusses the climate sensitive decisions for agricultural producers facing extreme climate events; Section 5 tackles sources and use of climate information, and price dynamics and critical decisions influenced by climate risks from the point of view of the farmers, traders/disposers and agriculturists; and, Section 6 concludes the paper.

2. Literature review of valuing climate information

The common theme in the literature for valuing climate information and forecasts is based on decision theory. These can be categorized into the following methodological procedures; cost/loss ratio, contingent valuation/willingness-to-pay, and using econometric models.

The simple cost/loss ratio is described by Lee and Lee (2007) as model that where a protective action is taken depending whether or not a particular adverse weather event is forecast. The authors expounded that the protective action can save losing expenses with a smaller cost for protection, or an even larger loss is incurred if the protective action is not taken and adverse weather occurs. This model is a particularization of prototype decision models in which agent must decide between two actions whether to protect the harvest from adverse meteorological situation with a corresponding cost or not to protect it and expose the farmers to a loss if the adverse event takes place (Tena and Gomez, 2008). The paper by Sonka et al (1986) used this method in analyzing corn decision and production process. The authors concluded that the value of climate forecasts could provide substantial increases to variable costs. The results suggest that climate forecast information has relatively greater value during time of moderate

economic adversity. On output prices, climate forecasts consistently have less relative value when output prices are higher. Higher output prices motivate the producer to select strategies which will maximize yield with less regard to expected climate conditions. Input cost levels also affect the value of forecasts as higher inputs costs reduce the value of climate forecast information. With higher input costs and low output price producers are motivated to adopt cost reducing strategies regardless of expected climate information. Identification of the decision choices that are sensitive to climate forecast information are those relating to fertilization are most affected by forecast availability. Timing of harvest also varies between early and late harvest when climate forecasts are available. Fall, late spring, and early summer stages have the greatest potential for climate forecasts. The early summer stage is important because of the climate/nitrogen fertilizer interaction defined for the period. The late spring is important because of the potential delaying the application of fertilizer.

The contingent valuation (CV) is a valuation for non-market goods and weather and or climate services are not typically paid for by the public. This can be estimated using techniques called stated preference methods. In its simplest terms, CV is a survey based technique used to elicit the maximum amount in monetary terms that an individual, household or business would be willing to pay for a non-market good. Climatic services have also been assessed using the willingness to pay (WTP) using Cv method. WTP is a very common and widely adopted method to make a perceived value assessment. The method is where the valuators are place in a position to make a statement concerning how they see the value of the valuation object. In 1996, Anaman and Lellyett found out that households in Sydney metropolitan area indicate that the average annual WTP for public weather forecast and warnings was about $18. In another study, Lazo and Chestnut (2002) indicated that the median household WTP for weather forecast in the United States was $109 per year. But Brown and Murphy (1987) in their survey to natural gas companies for willingness to pay for different types of climate forecasts found out that the estimates obtained were highly variable and differ greatly among companies. Moreover, as noted by Leviakangas (2009) WTP often fails the market test which means that when the services are actually delivered to the marketplace, the WTP values might not be realized or can be substantially lower than what the WTP suggests.

The studies using econometric models to determine the value of climate services. Frehner (2016) used multiple regression analyses to assess how climate data relates to simulated yields. The aim was to identify the two most important climatic indicators for the yields of quinoa and potatoes with a goal of maximizing the expected revenue one with and without seasonal climate forecast. Frisvold and Murugesan (2012) examined the use of weather information in agricultural decision utilizing multivariate regression models. The dependent variable equaled one if producer used weather data for a particular agricultural management decision and zero otherwise while the independent variables are farm sales variables, socio-demographic, farm characteristics. The results confirm that although greater age was associated with placing importance on more types of weather data, older producers were only more likely to use the forecasts. Several individual decisions tend to increase with the share of household income devoted to farming. This suggests that households more reliant on agriculture for their total income have more at stake in adapting to weather conditions. Land ownership was significant it had a negative impact, while the importance rating of risk management programs and satellite TV ownership had positive impacts. Lastly, the electronic-mail access had no significant effect on use of weather data for individual decisions. Wood et al (2014) used linear regression modeling approach to explore the relationship between the number of reported farm changes, access to weather information, wealth, group membership, and other covariates. The model was a generalized linear model with a binomial link

function, for which the probability of making any change was the key response variable. The results of the study which relates to climate information stated that households that reported having access to immediate or short-run weather forecasts were more likely to have some change in their farming practices in the last 10 years. Access to weather information is also significantly related to the likelihood of adopting improved crop varieties, making adjustments in the timing of agricultural activities, land management practices, related to increasing fertilizer use as well adopting improved varieties.

3. The Cordillera Autonomous Region (CAR)[2]

A landlocked region, Cordillera Administrative Region (CAR) is located in the northern central portion of Luzon. It is bounded on the north by the provinces of Ilocos Norte and Cagayan; on the south by the provinces of Pangasinan and Nueva Vizcaya; on the east by Cagayan Valley; and on the west by the Ilocos Region. It has a total land area of 18,293.70 square kilometers which is about 16% of the total land area of the Philippines *(see Figure 1).*

CAR was created by Executive Order No. 220 signed by former President Corazon C. Aquino on July 15, 1987, otherwise known as the Organic Act of CAR. Originally, the region was composed of the provinces of Abra, Benguet, Ifugao, Kalinga-Apayao, Mt. Province and the City of Baguio *(see Table 1 for the population).* The provinces of Abra, Benguet, Mt. Province and Baguio City were formerly part of the Ilocos Region while Kalinga-Apayao and Ifugao were part of the Cagayan Valley Region.

The region is dominated by a mountainous topography, characterized by very steep slopes and high elevation. About 71% of its land area has steep slopes, which constrains cost effective physical development. Infrastructure projects, for example, are 30% more expensive in CAR compared to similar projects in the lowland areas because the process of incorporating mitigating measures further aggravates construction costs. Thus, determining the appropriate location of projects is critical in the face of the region's topography and cost of construction.

More than 75% of the region is classified as high elevation (500-2,000 meters above sea level). This gives the region its generally cool climate which nurtures many unique and rare bio-species, and attracts many domestic tourists escaping from the sweltering lowland heat.

Located in a seismo-tectonically active area, and owing to its unique topography, the region is highly prone to geologic hazards such as mass movements, ground subsidence, seismic induced hazards, and flooding. The region is entirely traversed by numerous active fault lines including branches of the Digdig Fault. The July 16, 1990 earthquake caused major damage to private and public properties estimated at PhP 3.7 Billion.

The region is mainly mountainous, situated within the Cordillera Central mountain range. Mount Pulag, the highest mountain in Luzon, is located at the tri-point of Benguet, Ifugao, and Nueva Vizcaya provinces. The region has several rivers. The most extensive in the region is the Chico River, a major tributary of the Cagayan River, traversing the provinces of Mountain Province and Kalinga. Other major

[2] This section borrows heavily from this website http://blgf.gov.ph/?regional_offices=car-2

rivers include Agno, Amburayan, Bued in Benguet, Abulog in Kalinga, Abra River in Abra, Ahin River in Ifugao, Apayao River in Apayao, and Siffu River in both Ifugao and Mountain Province.

Sandoval and Baas (2013) documented that the frequent and intense occurrences of climate-induced natural disasters have affected the region's farmers, including those in the nearby lowland provinces. Climate change has escalated the uncertainties in the region's agricultural production as the increased occurrence, intensity, and length of rainfall events have consequently increased erosion rates, triggered landslides, and made certain crops susceptible to diseases. Such changes have impacted crop production in the region, particularly during the crops' critical growth stages. The same authors added that in the province of Benguet, observed problems include soil nutrient depletion, vulnerability to landslides, and crop failure due to more extreme temperatures. On the other hand, Ifugao province is also vulnerable to landslides and experiences irregular rainfall, longer dry spells, and intense typhoons which have made rice production difficult for the farmers.

Population

The Cordillera Autonomous Region (CAR) has, and continues to be the least populated region in the country accounting for less than two percent of the total national population. The population growth rate of CAR is also lower (1.53%) than the national average growth rate of 1.84 percent from the years 2000-2015 *(see Table 1 below).* Benguet Province registered the highest population share in Cordillera Administrative Region (CAR) at 44 percent in 2015. Its population size is almost half of the total region's population while the province's population growth rate for the period 2000-2015 is higher than the regional and national average. This high growth rate can be attributed to hosting some of the regional offices and serving as a major trading center of agricultural products in CAR as well as neighboring regions. CAR is inhabited by a predominantly indigenous population mainly the Kankanaeys, Ibalois, Bontocs, Ifugaos, Kalingas, Isnegs, Tingguians and other smaller minority groups with very distinct cultural characteristics and traditions[3].

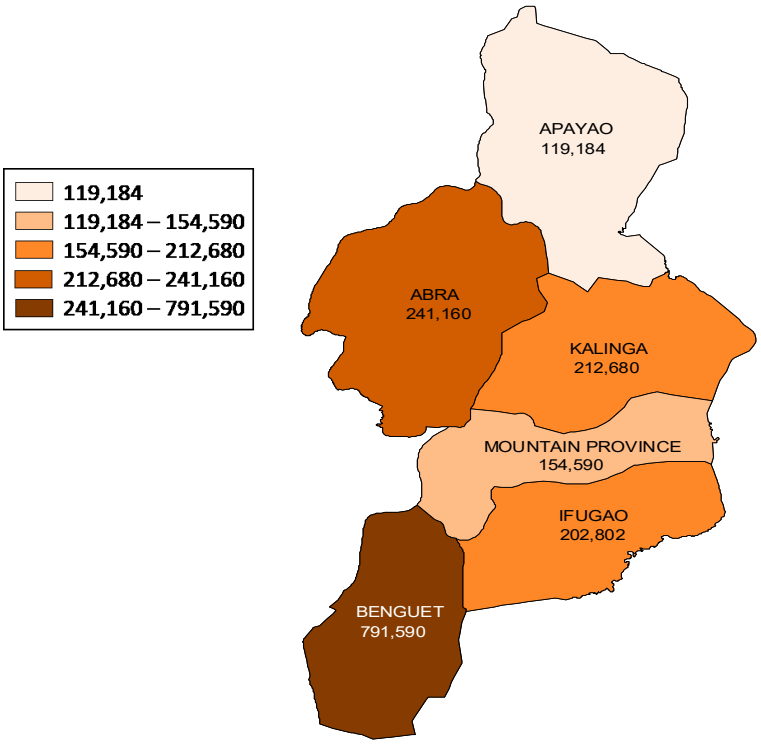
Table 1. Cordillera Administrative Region Population and Population Growth Rates

	Total (million)			Share (%)			Growth Rate (%)		
	2000	*2010*	*2015*	*2000*	*2010*	*2015*	*2000-2010*	*2010-2015*	*2000-2015*
Philippines	76.50	92.30	10.10	-	-	-	1.90	1.72	1.84
Cordillera Admistrative Region (CAR)	1.37	1.62	1.72	1.78	1.75	1.71	1.70	1.21	1.53
Abra	0.21	0.23	0.24	0.27	0.25	0.24	1.14	0.52	0.93
Benguet *(excluding Baguio City)*	0.33	0.40	0.45	0.43	0.44	0.44	2.04	1.91	1.99
Baguio City	0.25	0.32	0.35	0.33	0.35	0.34	2.36	1.54	2.08
Ifugao	0.16	0.19	0.20	0.21	0.21	0.20	1.69	1.14	1.5
Kalinga	0.17	0.20	0.21	0.23	0.22	0.21	1.48	1.02	1.32
Mountain Province	0.14	0.15	0.15	0.18	0.17	0.15	0.92	0.05	0.62
Apayao	0.97	0.11	0.12	0.13	0.12	0.12	1.49	1.08	1.35

[3] Cordillera Development Plan 2011-2016, NEDA

Source: Philippine Statistics Authority, *various years*

Figure 1 Population of Cordillera Autonomous Region, 2015



Benguet Province[4]

Nature has endowed Benguet with immense riches. Mineral deposits and fertile soil abound. Mineral deposits in the province include, gold, silver and copper. Its unique temperate climate alone is a distinctive asset[5]. Benguet is located on the southernmost part of the Cordillera Administrative Region between 16'10" and 16'33" north latitude and 120'34" to 120'52" east longitude. It is bounded on the north by Mountain Province, on the south by Pangasinan, on the west by La Union and Ilocos Sur, and on the east by Nueva Vizcaya and Ifugao. Rising thousands of feet above sea level is the second highest mountain in the Philippines, Mt. Pulag, located in the municipality of Kabayan. Elevation ranges from 200 meters to 2,792 meters, the highest at Mt. Pulag. The Halsema Mountain Highway, 95 kilometers of which are in Benguet, traverses the province from south to north. The highest point of the Philippine Highway System, 2,256 meters above sea level, is at Mt. Paoay, Atok.

Of the province's total land area of 2,616.48 square kilometers, forest land comprises 1,747.40 sq. km. (66.78%) while alienable and disposable lands make up 869.08 sq. km. (33.22%). Classified forest

[4] http://www.dilgcar.com/index.php/2015-07-10-07-24-09/province-of-benguet
[5] http://www.benguet.gov.ph/index.php/fast-facts

land is distributed as follows: forest/watershed reservation is 657.43 sq. km., timberland is 233.61 sq. km., national parks is 698.67 sq. km., military reservation is 5.54 sq. km. and civil reservation is 152.15 sq. km.

For water resources, the province has four major river systems namely Agno, Amburayan, Abra, and Naguilian-Trinidad. Among these, Agno River is the longest followed by the Abra River Sytem, Naguilian-Trinidad River and Amburayan River System, respectively. These river systems serve multiple purposes ranging from domestic water supply use, irrigation and agricultural purposes, to power and energy and tourism.

The province is accessible by land transport via the following entry points: from Pangasinan through Kennon Road; La Union through either Marcos Highway at Rosario or Naguilian Road at Naguilian; Mountain Province through the Halsema Highway; Nueva Vizcaya, through the Benguet-Nueva Vizcaya Road; and Ilocos, through the Abatan-Mankayan-Cervantes Road. These road networks converge in Baguio City, the center of trade and commerce in the province.

Benguet has one congressional district and is politically sub-divided into two (2) board member districts with a total of 13 municipalities (*see Figure 2*) and 140 barangays. District 1 which comprises 5 municipalities has a population of 147,941 while District 2 with 8 municipalities has a total population of 298,283. La Trinidad, the capital, has the highest population which accounts for 129,133 followed by Itogon with a population of 59,820. Meanwhile, the municipalities of Sablan and Bokod are ranked as the least populous places in the province with populations of 11,457 and 13,756, respectively *(see Table 2).*

Benguet is the fourth biggest province in the region in terms of land area. Across municipalities in the province, Itogon is the largest in terms of land area followed by Tuba and Bakun. It is noted, however, that La Trinidad, the provincial capital is the third smallest town in terms of land area.

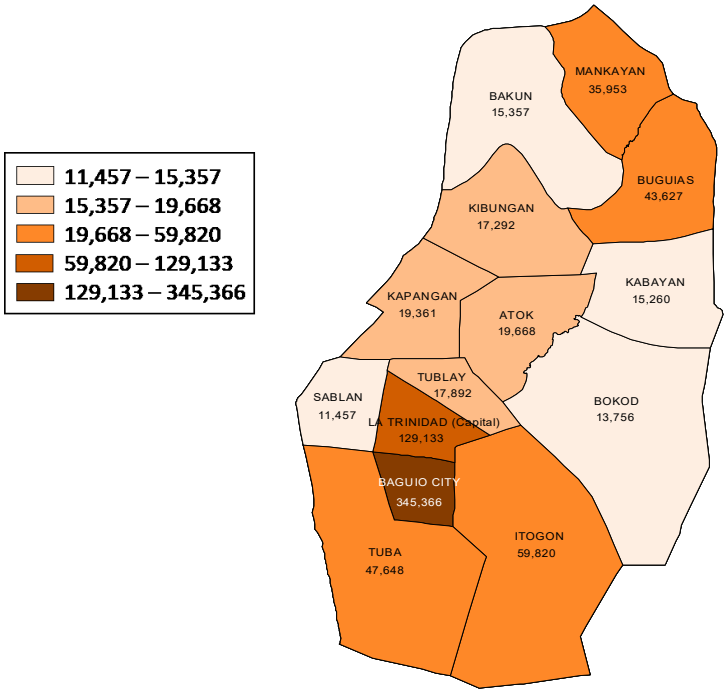
Table 2. Municipalities of Benguet Province, Land Area, Income Class, Barangays and Population

Municipality	Land Area (Sq.Km)	Income Class	Number of Brgys.	Population*
Atok	223.86	4th	8	19,668
Bakun	307.69	3rd	7	15,357
Bokod	396.40	4th	10	13,756
Buguias	162.6	3rd	14	43,627
Itogon	498.00	1st	9	59,820
Kabayan	277.52	4th	13	15,260
Kapangan	173.27	4th	15	19,361
Kibungan	261.08	4th	7	17,292
La Trinidad (Capital)	82.74	1st	16	129,133
Mankayan	175.14	1st	12	35,953
Sablan	48.12	5th	8	11,457
Tuba	390.42	1st	13	47,648
Tublay	57.30	5th	8	17,892

* based on the 2015 CPH, PSA
Source: http://www.dilgcar.com/index.php/2015-07-10-07-24-09/province-of-benguet

In terms of income classification, four municipalities in the province, namely La Trinidad (capital), Itogon, Tuba, and Mankayan belong to the 1st class municipalities. On the other hand, more than half of the total number of municipalities fall under the 4th and 5th classes *(see Table 2 above).*

Figure 2 Population of Benguet Province, 2015



Agriculture has been the traditional and still the major source of employment for the people in the province. At least 54% of the labor force are engaged in vegetable/cut flower farming. Vegetable products from the province supply 80% of vegetable needs of the metropolis. Vegetables grown are cabbage, Chinese cabbage, broccoli, cauliflower, potatoes, carrots and other temperate vegetables. Cutflower production is also gaining attention because of its promising profitability. These are roses, chrysanthemums, lilies, carnation, Shasta daisies and others. The "Rose Garden of the Philippines" is located in the province particularly Barangay Bahong, La Trinidad. Rugged and sloping terrain and valleys characterize the province. The three major ethnolinguistic groups are the Ibalois, Kankana-eys and the Kalanguyas. Although the three groups speak different dialects, they share similar cultures and have common beliefs and rituals. They believe in gods and spirits influencing their day to day activities.

In 2010, the Cordillera Highland Agricultural Resource Management Project (CHARM) promoted organic farming production systems in Cattubo, Atok, Benguet, but noted that very few farmers are adopting the technologies promoted. The main reason cited by the farmers for low-adoption is the lack of a market[6]. In Mankayan, Benguet where vegetable farming is the most important economic activity,

[6] http://asia.ifad.org/web/749-ph/themes?p_p_id=1_WAR_ifad_about_devthemesportlet&p_p_lifecycle=0&p_p_state=normal&p_p_mode=view&p_p_col_id=column-1&p_p_col_count=2&p_r_p_564233524_categoryId=10842&#p_1_WAR_ifad_about_devthemesportlet

in-depth analysis of the farming communities reveals some constraints to higher economic productivity among producers. An average farm size between 2,500 square meters to one hectare and an average family size of five members lead to diseconomies of scale in agriculture production. It was also observed that many farmers are now starting heavy use of inorganic and or chemical pesticides and fertilizers. This has resulted in worsening soil quality and an increase in resistance of pests and diseases. Thus, there is increased use of inputs but without much leeway in the adjusting the prices of their produce. It was also observed that mono cropping or over production of a certain crops results in poor margins for many vegetable farmers. The farmers have a strong tendency to imitate their neighbor's farm and decide to cultivate certain crops based on poor or limited information and foresight (Baybay, 2012).

The province is a leading producer of vegetables, it also has potential for growing oranges, pears and other temperate fruits. Recently, the term "Strawberry Country" has been added to the province's title. In Benguet, vegetable farmers brought their produce either directly or through the assembler wholesalers, commission agents or wholesalers to the La Trinidad Trading Post and Hangar Market. The traders at the trading post initially got a large proportion of the farmers' produce. Subsequent trading activities, however, occurred where vegetables sold at the trading post went to the Hangar market. Some of these vegetables were sold in the domestic market through local wholesaler-retailers and retailers while the major proportion of about 73% and 17% were brought out of the region through the large assembler-wholesalers and wholesalers (Piadozo, 2013).

Data from the Office of the Provincial Agriculture in Benguet revealed that in terms of average production in metric tons from 2002 to 2015, potatoes (18,666 mt) is the top commodity produced followed by cabbage (14,790 mt) and chayote at 9,472 metric tons. Carrots is the top four with 7,219 metric tons and completing the top five is Chinese cabbage with 4,222 metric tons' production from 2002 to 2015. Even looking at the five-year average production from 2011 to 2015, we can still infer that the same vegetables are in the top five in Benguet. About 19.5 thousand metric tons for potato, chayote (17.5 mt), cabbage (16.9 mt), carrots (8.8 mt) and completing the top five is Chinese cabbage at 4,447 metric tons. In terms of average production from 2011 to 2015 Broccoli is included in the top 10 produced vegetables in Benguet. Table 3 below provides the details.

Table 3. Top 10 Agriculture commodities in Benguet, in metric tons

	Average production	2002-2015		2011-2015
1	Potato	18,666.0	Potato	19,583.0
2	Cabbage	14,790.5	Chayote	17,515.9
3	Chayote	9,472.2	Cabbage	16,962.4
4	Carrots	7,219.2	Carrots	8,995.8
5	Chinese cabbage	4,222.1	Chinese cabbage	4,447.7
6	Potato seeds	2,738.0	Rice	1,413.1
7	Rice	1,389.4	Cauliflower	963.1
8	Snap beans	896.3	Snap beans	956.3
9	Cauliflower	878.2	Sweet Potato	796.7
10	Sweet Potato	833.9	Broccoli	704.8

Source: Office of the Provincial Agriculture, Benguet, 2017

We also looked at other agricultural produce in Benguet particularly fruit trees and some plantation crops. It can be observed that there is a changing pattern in the production of fruit trees and plantation crops. In terms of average production from 2002 to 2015, the top agriculture produce are; Mango (353,124 kg), Citrus (209,434 kg), Santol (98,565 kg), Lemon (87,909 kg) and Pomelo (75,753 kg) which completes the top five agriculture produce from 2002 to 2015. But examining the production data from 2011 to 2015 revealed an interesting shift in the pattern of production in Benguet for these agricultural commodities. In terms of average production from 2011 to 2015, Sugarcane is the top produce (594,000 kg), Banana (459,066 kg), Citrus (246,910 kg), Santol (142,073 kg) and Guapple (105,981 kg). Figure 4 below shows the details.

Table 4. Top 10 Fruit trees and plantation crops in Benguet, in kilograms

	Average production	2002-2015		2011-2015
1	Mango	353,124.9	Sugarcane	594,000.0
2	Citrus	209,434.2	Banana	459,066.1
3	Santol	98,565.6	Citrus	246,910.2
4	Lemon	87,909.4	Santol	142,073.8
5	Pomelo	75,753.8	Guapple	105,981.7
6	Tamarillos	62,263.6	Tiger grass	95,736.2
7	Avocado	60,537.3	Lemon	87,909.4
8	Guapple	49,727.7	Avocado	87,705.6
9	Sweet oranges	46,614.0	Papaya	84,268.4
10	Jackfruit	38,324.7	Coconut	81,321.5

Source: Office of the Provincial Agriculture, Benguet, 2017

As the province is also known to produce cut flowers, we also looked at the average production from 2002 to 2015. Chrysanthemum with an average production of 1.59 million dozen is the top produced, followed by Roses with 747,585 dozen and Carnation at 715,217 dozen 2002 to 2015. Fourth is Alstromeria (359,088 dozen) and fifth are Dahlia and Lilies at 225,373 dozen for the same time period. We then also looked at the average production from 2011 to 2015, it shows that the same type of cut flowers are produced in Benguet.

Table 5 Top 10 Cut Flowers Production in Benguet, by dozen

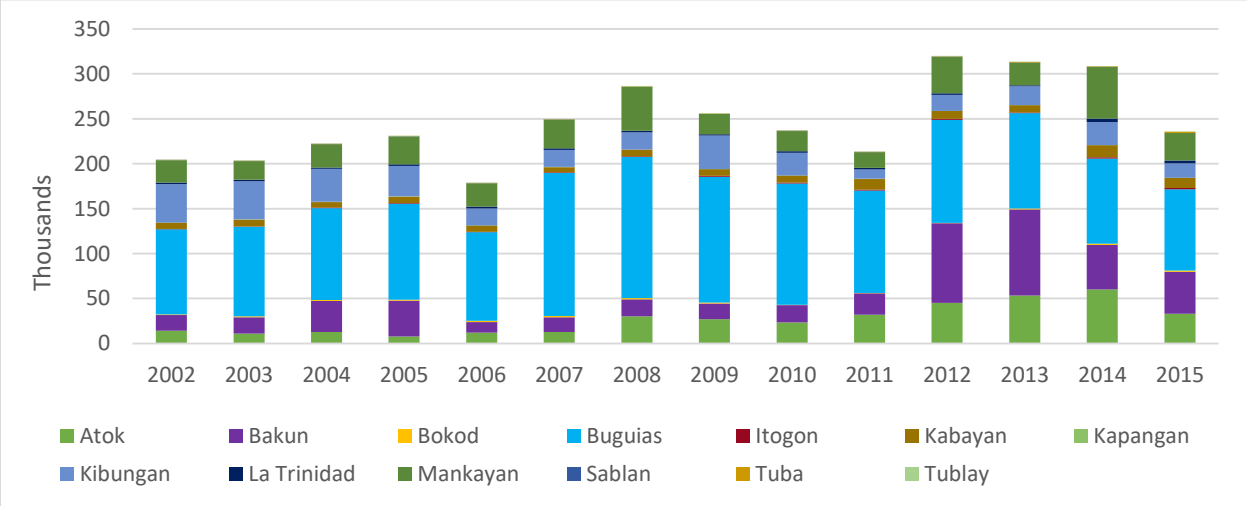
	Cut Flowers	2002-2015		2011-2015
1	Chrysanthemum	1,589,373.14	Chrysanthemum	1,709,092.6
2	Rose	747,585.09	Carnation	1,000,118.4
3	Carnation	715,217.58	Rose	872,269.3
4	Alstromeria	359,088.54	Alstromeria	565,955.1
5	Dahlia Lilies	225,373.00	Calalily	361,585.6
6	Gladiola	211,949.00	Shasta daisy	202,510.9
7	Calalily	178,895.07	Gladiola	160,134.3
8	Shasta daisy	121,877.63	Statice	146,927.9
9	Babiesbreath	115,895.52	Anthurium	136,951.4

10	Anthurium	107,011.78	Babiesbreath	132,993.6

Source of basic data: Office of the Provincial Agriculture, Benguet, 2017

Figure 3 below shows the total production of cabbage in Benguet from 2002 to 2015 in million metric tons. It can be said that highest production of cabbage in the Province is Buguias with a total of 1.61 million metric tons from 2002 to 2015. This is followed by Bakun (496, 824 mt), Mankayan (426,904 mt), Atok (376,059 mt), Kibungan (366,084 mt) and Kabayan (116,885 mt). The rest of the municipalities produced only less than 30 thousand metric tons of cabbage for the same time period, La Trinidad (27,215 mt), Bokod (14,601 mt), Itogon (11,501 mt), Tuba (4,643 mt), Kapangan (1,986 mt), Tublay (1,608 mt) and Sablan (545 mt).

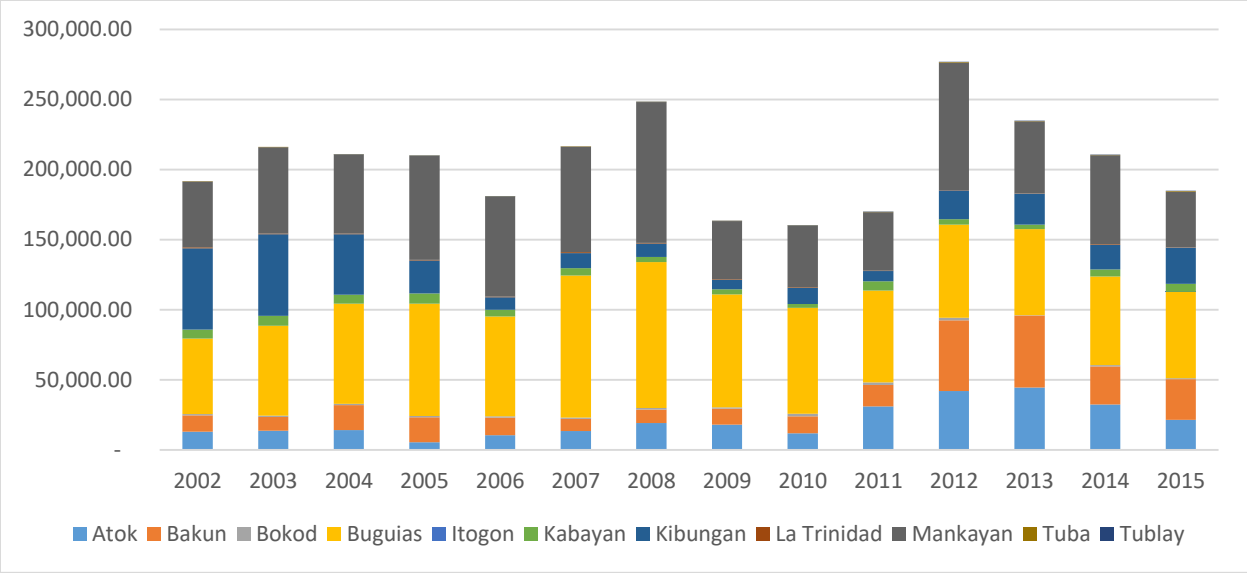
Figure 3. Total Cabbage Production in Benguet, Philippines 2002-2015 (in metric tons)



Source of basic data: Office of the Provincial Agriculture, Benguet, 2017

Figure 4 shows the total production of potatoes in the Benguet from 2002 to 2015. A total of 205,326 metric tons was harvested. Buguias has the biggest bulk of the production of potatoes in the province which was 72,906 metric tons followed by Mankayan with 61,355 metric tons. Completing the top five are Kibungan (23,136 mt), Atok (20,878 mt), and Bakun (20,311 mt).

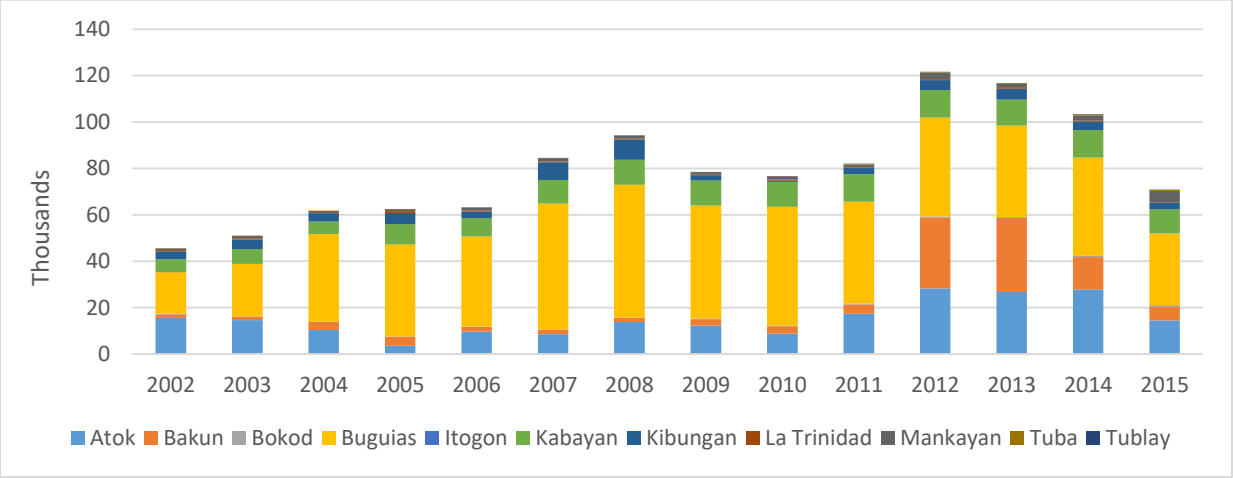
Figure 4. Total Potato Production in Benguet, 2002-2015 (in metric tons)



Source of basic data: Office of the Provincial Agriculture, Benguet, 2017

Figure 5 provides the details of the total production of carrots in Benguet Province from 2002 to 2015. A total of 1,110,981 metric tons were harvested for thirteen years. The leading producer of carrots is the municipality of Buguias (566,977 mt), this is followed by Atok (211, 828 mt), Kapangan (133,443 mt) and Bakun (108,534 mt).

Figure 5. Total Carrots Production in Benguet, 2002-2015 (in metric tons)



Source of basic data: Office of the Provincial Agriculture, Benguet, 2017

We also provided some estimates of the profit or earnings per hectare of the agricultural producers in Benguet. Table 6 provides the yield or harvest per hectare for the selected crops or vegetables which are cabbage, potato and carrots. These figures were obtained during the fieldwork in Atok and La Trinidad, Benguet in May 2017. We asked the focus group discussion participants on the estimated yields (column 1), the maximum, normal and minimum. The notion of maximum yield is analogous to best harvest and normal yield is the average while minimum is perceived to be when there

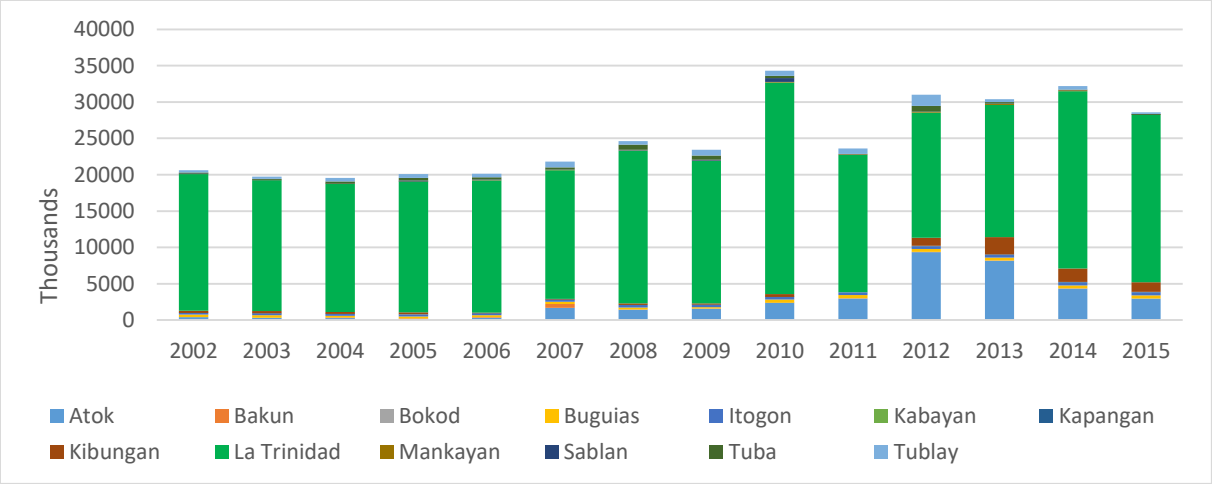
are extreme weather conditions. The selling prices were also shared by the agricultural producers and are considered to be fair and acceptable price for them. These selling prices are perceived to be at least greater than the production costs to each of the crops in table 3. The estimated revenues are obtained by multiplying the yield in kilos to the selling price per kilos. It can be deduced that given the higher price of carrots per kilo the highest revenues are when there is maximum yield for carrots (11,461 USD) and even at the normal harvest for carrots still will get a revenue of about 10, 028 USD per hectare. Considering the cost of production in these selected crops, we also calculated the possible profits for each type of the vegetables. The highest possible profit is maximum condition in the production of potato (6,379.68 USD per hectare), then carrots (5,726 USD per hectare), and cabbage (4,041 USD per hectare).

Table 6. Estimated Production costs, revenue and profit for selected crops in Benguet, Philippines

Crops	Yield/hec[1]	Yield[2]	Selling[3] Price	Revenues[4]	Cost of Production[5]	Profit
		in kilos/hec	(in USD/kl)	(in USD)	(in USD)	(in USD)
Cabbage	Max	22,679.63	0.316	7,163.49	3,121.98	4,041.51
	Normal	11,339.81	0.316	3,581.75	3,121.98	459.77
	Min	3,175.15	0.316	1,002.89	3,121.98	(2,119.09)
Potato	Max	18,143.70	0.526	9,551.33	3,171.64	6,379.68
	Normal	9,071.85	0.526	4,775.66	3,171.64	1,604.02
	Min	7,257.48	0.526	3,820.53	3,171.64	648.89
Carrots	Max	18,143.70	0.632	11,461.59	5,735.52	5,726.08
	Normal	15,875.74	0.632	10,028.89	5,735.52	4,293.38
	Min	7,257.48	0.632	4,584.64	5,735.52	(1,150.88)

Notes: [1]data for yield per hectare were based on the focus group discussions in Atok and La Trinidad, Benguet, Philippines on May 22-25, 2017.
[2]Original figures for yields are in tons, conversion of 1 ton= 907.185 kilos.
[3] The selling prices were obtained from FGD discussions and are considered "better" prices according to the participants. Conversion for the exchange rate 1 USD = 47.47 PhP. Average FOREX in the Philippines, 2016. Source: http://www.bsp.gov.ph/PXWeb2007/database/SPEI/ext_accts/exchange_en.asp
[4] Revenues were obtained by multiplying the selling price and the yield.
[5] Cost of production data were obtained from the Office of the Provincial Agriculture, Benguet, 2017

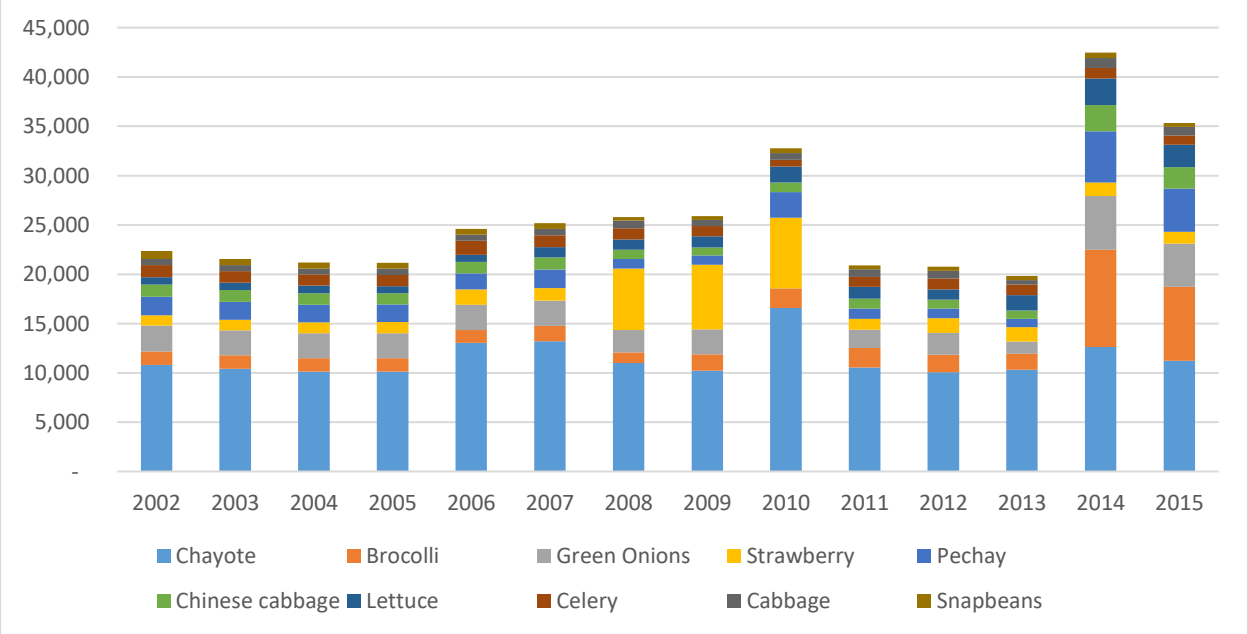
Figure 6. Total Cut Flower Production in Benguet, 2002-2015 (in dozens)



Source of basic data: Office of the Provincial Agriculture, Benguet, 2017

Figure 6 above shows total cut flower production in Benguet from 2002 to 2015 which was estimated to be around 18 million dozens of various cut flowers. These include; Chrysanthemum, Rose, Gladiola, Statice, Baby's breath, Anthurium, Dahlia, Lilies and Aster. La Trinidad accounts for the majority of the cut flower production in the Benguet with a total production of 15.2 million dozen of cut flowers. This is followed by Atok (872,167dozen), Kibungan (456,425 dozen), Sablan (343,393 dozen) and completing the top five is Tublay (341,827 dozen).

Figure 7. Top 10 Agriculture commodities in La Trinidad, Benguet, 2002-2015 (in metric tons)

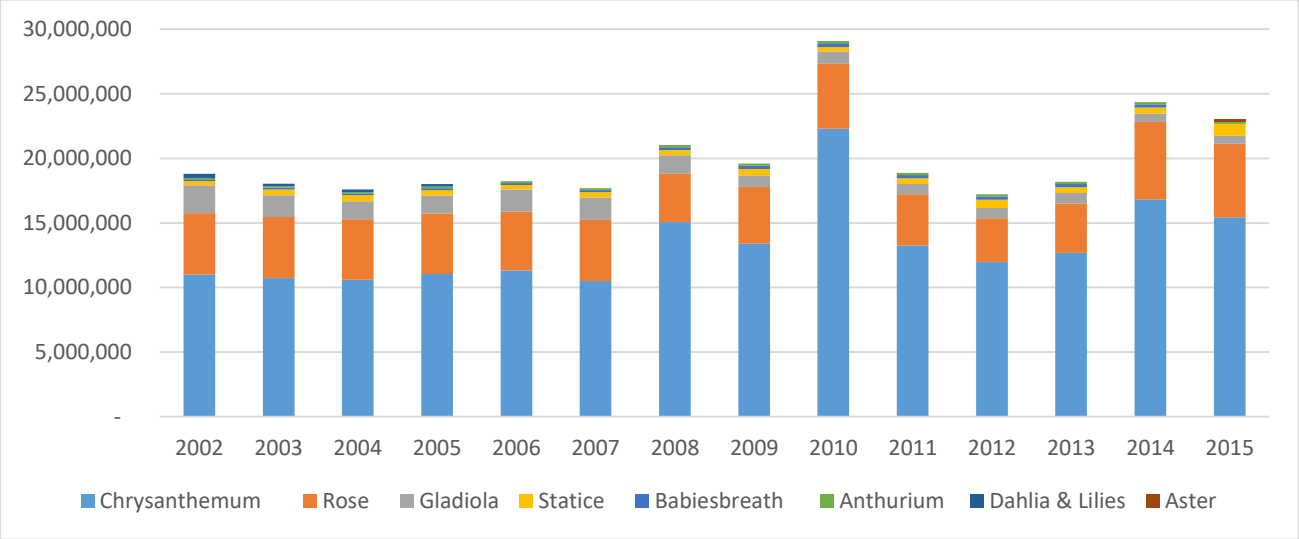


Source of basic data: Office of the Provincial Agriculture, Benguet, 2017

We also looked at the agriculture production in La Trninidad, Benguet, one of the study sites in this study. The top produced vegetables in La Trinindad in terms of total production in metric tons are; Chayote (160,378 mt), Brocolli (35, 830 mt), Green Onions (35,268 mt), Strawberry (33,648 mt) and

Pechay (27,767 mt). Completing the top 10 are; Chinese cabbage (17,449 mt), Lettuce (17,235 mt), Celery (15,362 mt), Cabbage (9,766 mt), and Snapbeans (7,194 mt). Figure 7 above provides the details.

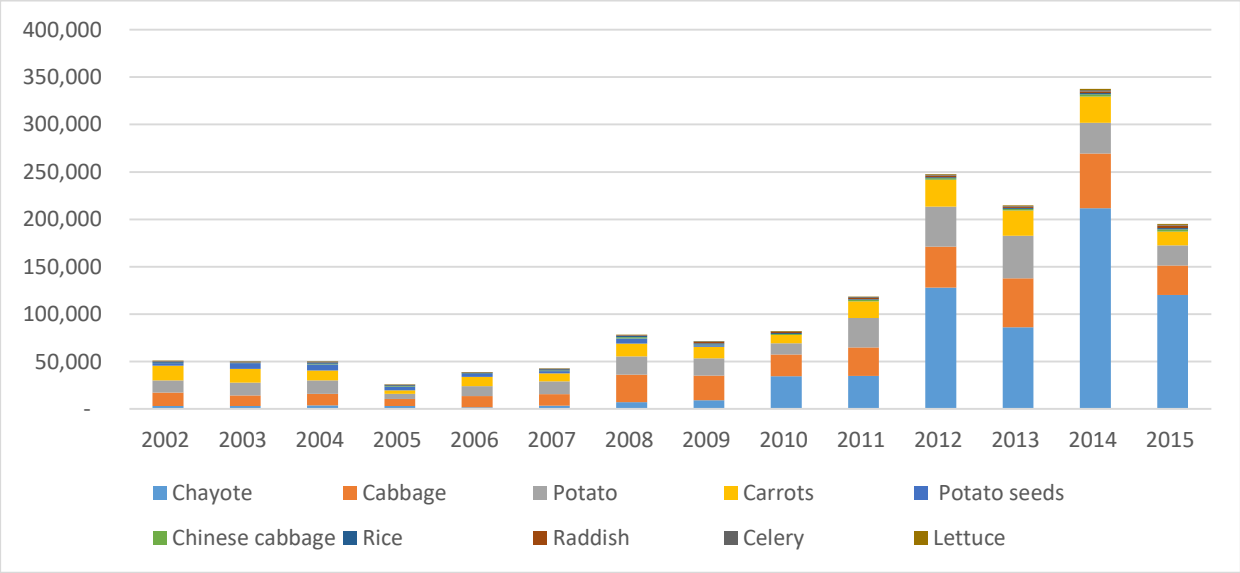
Figure 8. Total Cut flower production in La Trinidad, Benguet, 2002- 2015 (in dozens)



Source of basic data: Office of the Provincial Agriculture, Benguet, 2017

La Trinidad is known for cut flower production, Chrysanthemum is on the top of the production at 186 million dozen for thirteen years. Total Rose production is 642 million dozen, Gladiola (16.9 million dozen), Statice (6.6 million dozen), Babies breath (2.6 million dozen), Anthurium (2.1 million dozen), and Dahlia, Lilies and Aster (1.1 million dozen).

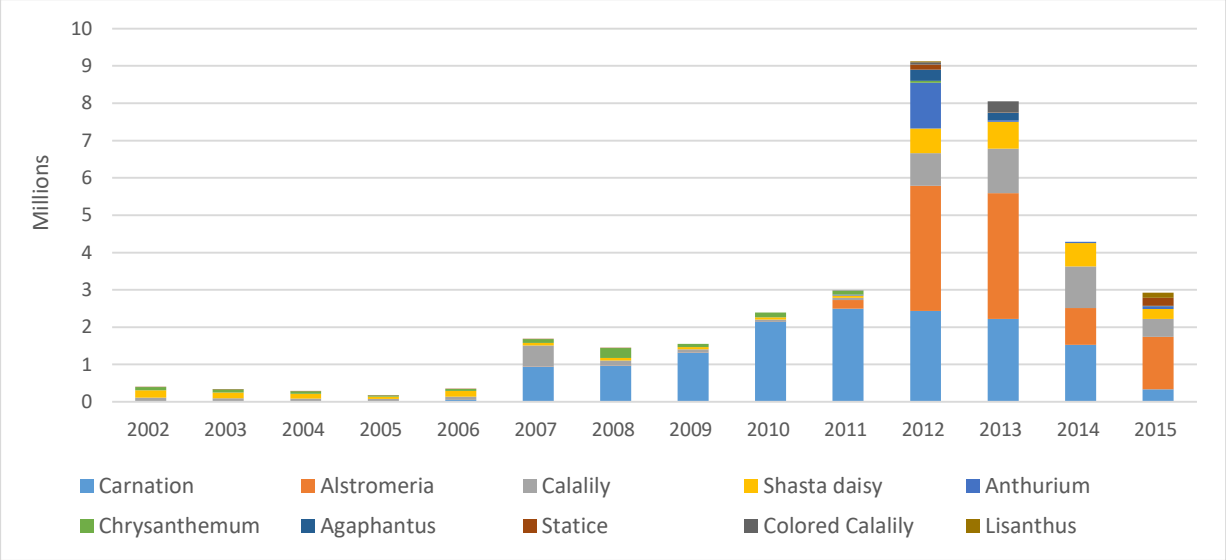
Figure 9. Top 10 Agriculture commodities in Atok, Benguet, 2002-2015 (in metric tons)



Source of basic data: Office of the Provincial Agriculture, Benguet, 2017

Another study site in this project is Atok, Benguet and examining the production data reveals that Chayote is the top agriculture commodity produced with a total production of 649,398 metric tons from 2002 to 2015. This is followed by Cabbage (360,054 mt), Potato (291,024 mt), Carrots (211,828 mt), Potato seeds (31,692 mt), Chinse cabbage (16,005 mt), Rice (14,961 mt), Raddish (13,425 mt), Celery (9,656 mt) and Lettuce (5,801 mt). Figure 9 above provides the details.

Figure 10. Total Cut flower production in Atok, Benguet, 2002- 2015 (in dozens)



Source of basic data: Office of the Provincial Agriculture, Benguet, 2017

Atok in Benguet is also known for its cut flower production where some of the bigger producer[7] and exporter of cut flowers are located. Looking at the production data from 2002 to 2015, Carnation is widely produced (14.5 million dozen), Alstromeria (9.3 million dozen), Calla Lilly (4.9 million dozen), Shasta daisy (3.3 million dozen), Anthurium (1.3 million dozen) and Chrysanthemum (1 million dozen) were produced from 2002 to 2015.

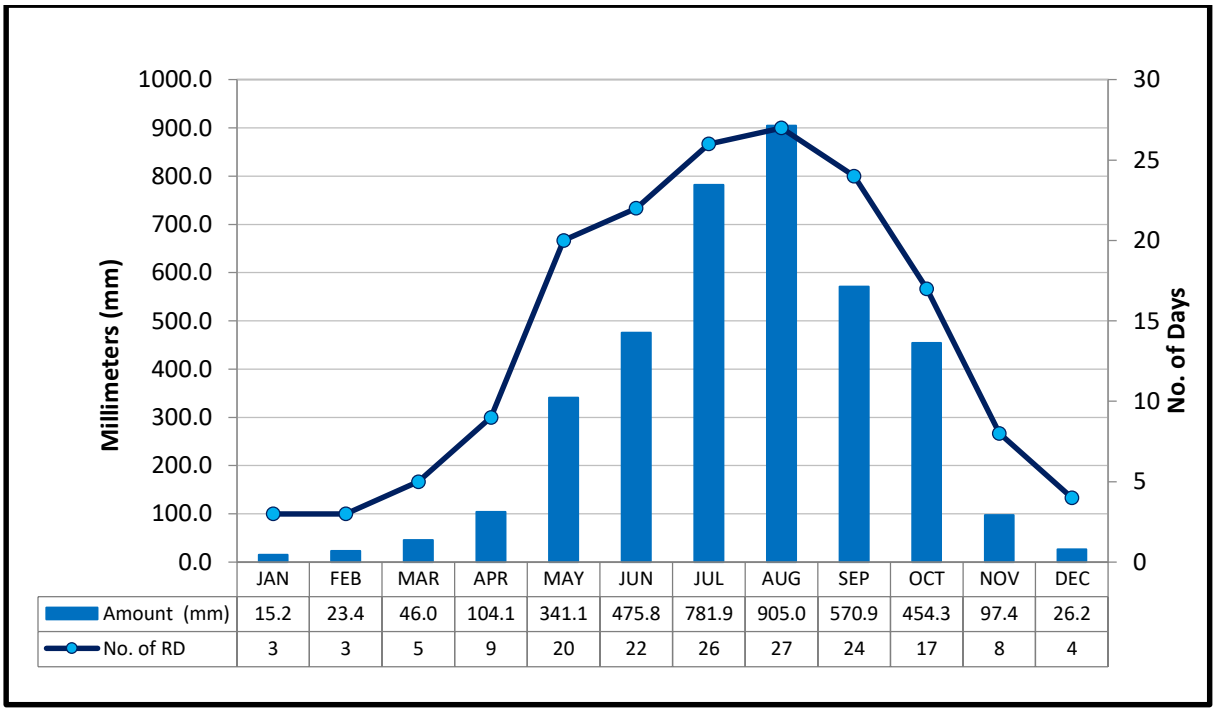
4. Climate in Benguet

Rainfall

The province of Benguet like many subtropical highland climate receives less precipitation during its dry season. However, during rainy season in the months of July and August the province receives extraordinary amount of precipitation. The wettest months August and July are having the highest rainfall with 781.9 mm and 905 mm respectively. Baguio City which is part of the Benguet province is one of the wettest places in the Philippines with an annual rainfall average of 3,841.1 mm based on its 1981 to 2010 climatological normal. The Baguio Synoptic Station recorded the greatest recorded 24-hour rainfall on July 4, 2001 at 1,085.8 millimeters. Please see figures 11 and 12 below.

Figure 11. Baguio synoptic station normal rainfall and number of rainy days, 1981-2010

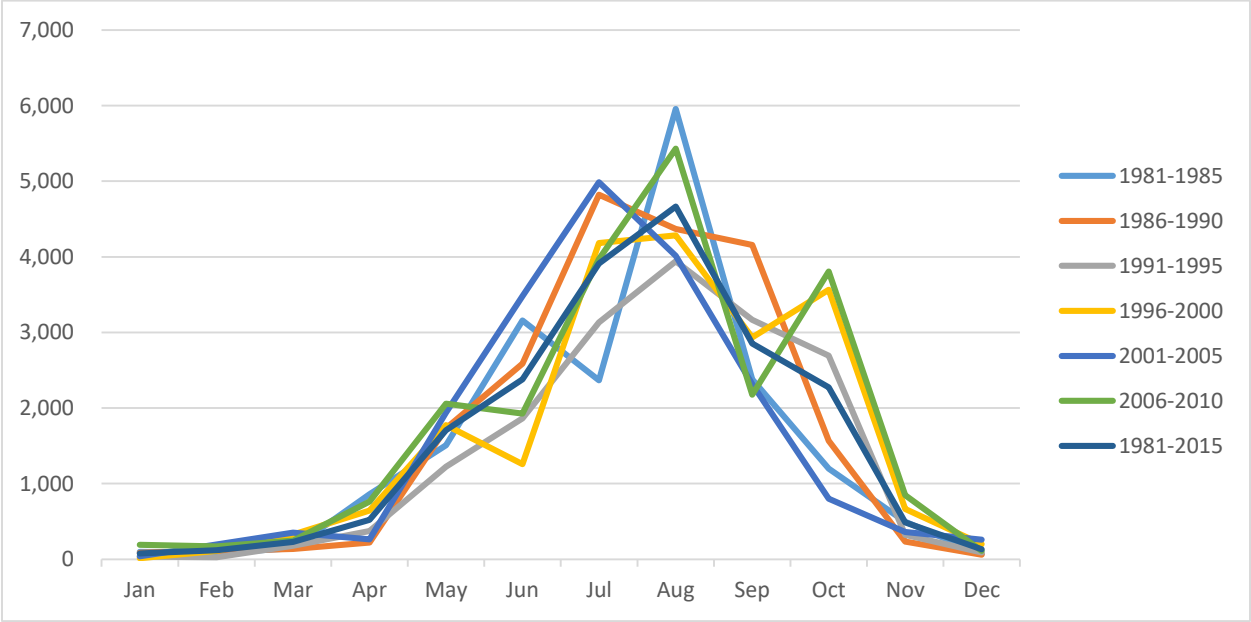
[7] Based on the FGD held in Atok Municipal Hall with some agriculture producers, May 2017



	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Amount (mm)	15.2	23.4	46.0	104.1	341.1	475.8	781.9	905.0	570.9	454.3	97.4	26.2
No. of RD	3	3	5	9	20	22	26	27	24	17	8	4

Source: PAGASA, Climate of Benguet Province, 2015

Figure 12. Five-year average monthly normal precipitation in Baguio Synoptic Station, 1981-2015

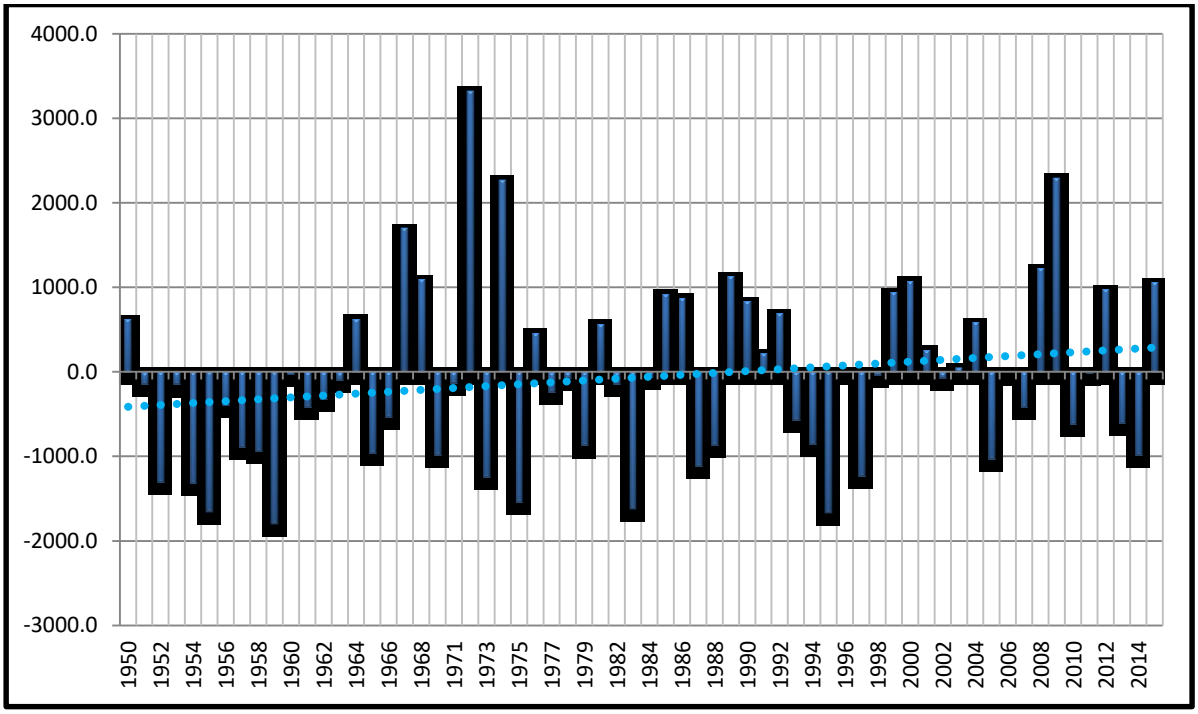


Source: PAGASA, 2017

The analysis of the annual rainfall in Baguio shows an increasing trend based from the difference on the actual data from 1950 to 2013, and the average of the 1981 to 2010 rainfall values. There were also reductions in rainfall during El Nino years in 1958, 1959, 1982, 1983, 1997 and 1998. Rainfall

increase was also observed in the years 1972, 1974, 2008 and 2009, these are La Nina years. See figure 13 below.

Figure 13. Annual departure of rainfall from normal in Baguio City, 1981-2010 and 1950-2015

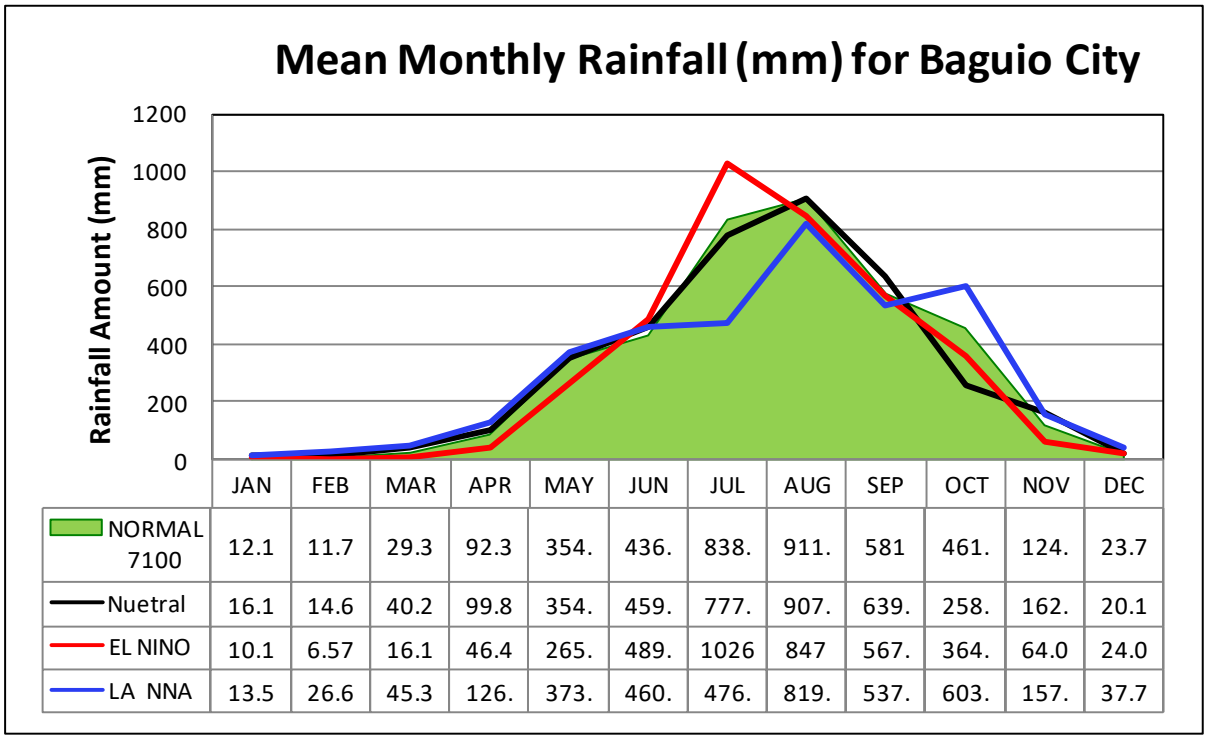


Source: PAGASA, Climate of Benguet Province, 2015

El Nino and La Nina

Figure 14 below shows the average monthly rainfall during the El Nino and La Nina years from the Baguio Synoptic station. Baguio receives above normal rainfall during the months of October to November during the La Nina months but below normal rainfall during El Nino months from August to May. Interestingly, during June, July and August, the rainfall amount is still above normal during El Nino and below normal rainfall during June, July and August during La Nina. Please see Figure 14 below.

Figure 14. Average month rainfall (mm), Baguio synoptic station



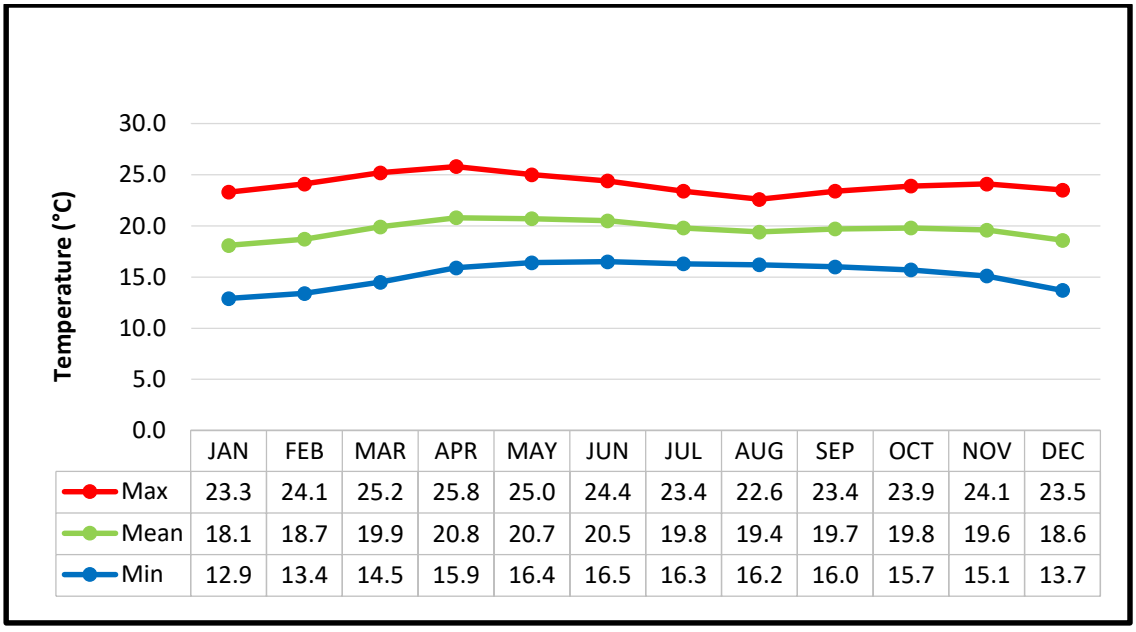
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
NORMAL 7100	12.1	11.7	29.3	92.3	354.	436.	838.	911.	581	461.	124.	23.7
Nuetral	16.1	14.6	40.2	99.8	354.	459.	777.	907.	639.	258.	162.	20.1
EL NINO	10.1	6.57	16.1	46.4	265.	489.	1026	847	567.	364.	64.0	24.0
LA NNA	13.5	26.6	45.3	126.	373.	460.	476.	819.	537.	603.	157.	37.7

Source: PAGASA, Climate of Benguet Province, 2015

Temperature

Due to its high elevation, the province of Benguet has mild climate with about 10 degrees Celsius compared to the temperature in the lowland areas. The mean temperature for the period 1981 to 2010 ranges from 18.1 degrees Celsius on January to 20.8 degrees Celsius on April based on data from the Baguio Synoptic Station. The lowest temperature recorded was 6.3 degrees Celsius on January 18, 1961 while the highest was recorded on March 15, 1998 at 30.4 degrees Celsius during the El Nino season. Please see Figure 15 below.

Figure 15. Baguio Synoptic Station Temperature, 1981-2010

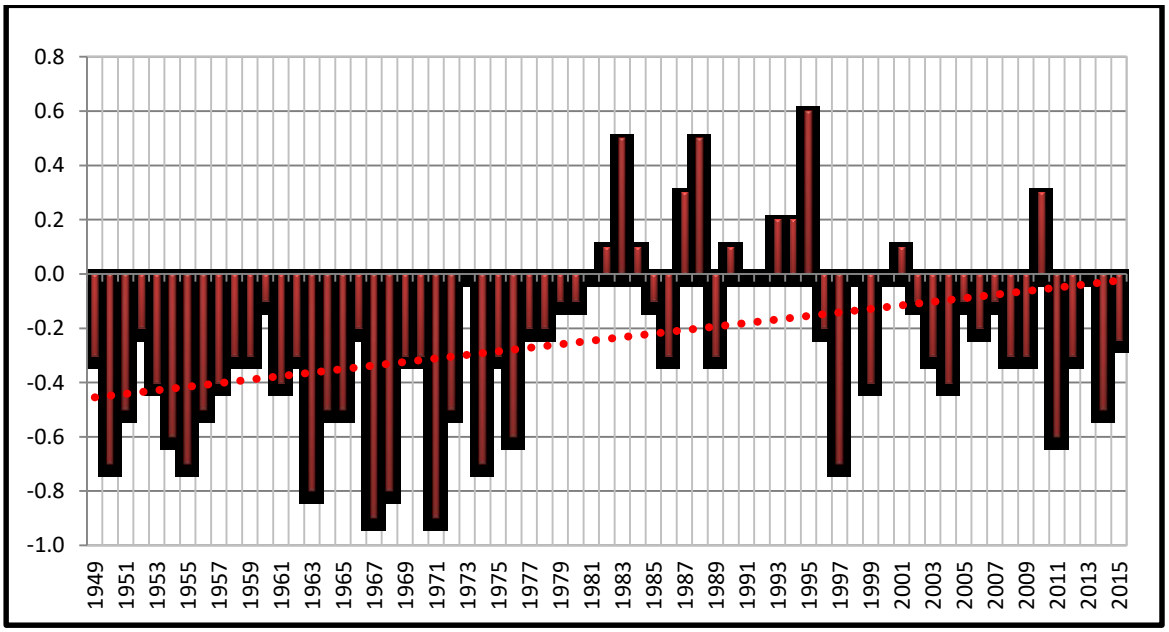


	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Max	23.3	24.1	25.2	25.8	25.0	24.4	23.4	22.6	23.4	23.9	24.1	23.5
Mean	18.1	18.7	19.9	20.8	20.7	20.5	19.8	19.4	19.7	19.8	19.6	18.6
Min	12.9	13.4	14.5	15.9	16.4	16.5	16.3	16.2	16.0	15.7	15.1	13.7

Source: Climate Benguet Province, PAGASA 2015

There is increasing trend in temperature in Benguet based on the data from the Baguio Synoptic Station. The basis for this is the difference in the actual data since 1949 to 2015 and the average of the temperature data from 1981 to 2010. For the last 65 years, an increase of 0.48 degrees Celsius was observed. The highest increase in temperature were evident during the years 192 to 1983 and in 1995 due to the El Nino phenomenon.

Figure 16. Annual departure of temperature from the normal from 1981-2010 and 1949-2015

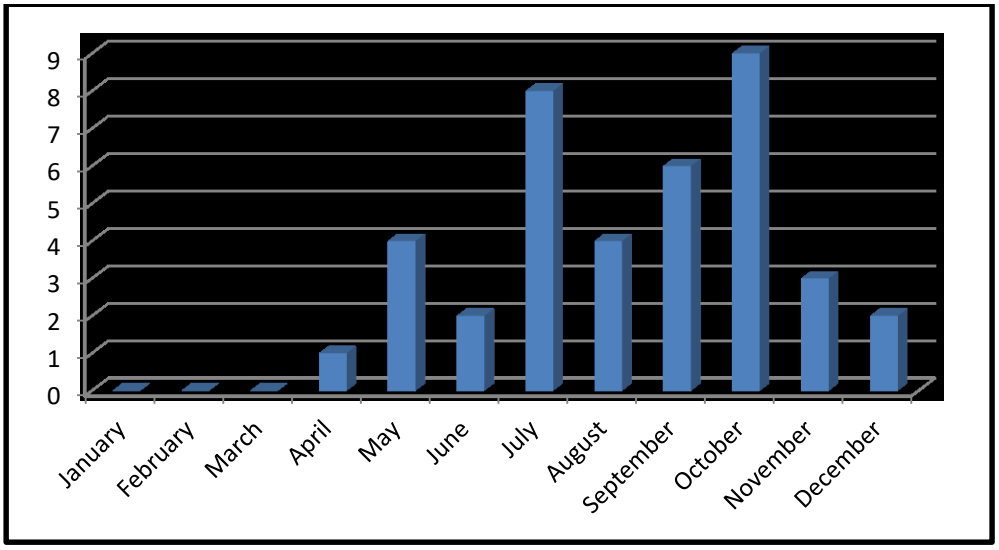


Source: Climate Benguet Province, PAGASA 2015

Tropical Cyclone/Typhoon

For a span of sixty-seven years, there were 39 tropical cyclones that crossed the province of Benguet. Twenty of these tropical cyclones reached the typhoon category, ten are classified by tropical storms and seven are tropical depressions. The months of July and October are considered to have the most number of tropical cyclones having seven and eight for the months mentioned. It is also rare have tropical cyclones during the first quarter of the year. Please see Figure 17 below. Appendix A lists all the tropical cyclones that crossed Benguet from 1948 to 2015

Figure 17. Monthly distribution of tropical cyclones that crossed Benguet, 1948-2015



Source: Climate Benguet Province, PAGASA 2015

Based from the reports of the local farmers and agriculturists, the areas in Benguet that were affected by frost are Atok, Buguias, Mankayan, Kabayan and Kibungan (Marasigan, 2017). Table below provides the details of the occurrences of frost in Benguet.

Table 6. Frost occurrence in Benguet, January 2008- February 2014

Date	Affected areas
January 5, 2008	Brgy. Paoay, Atok
January 27, 29-31 to February 1, 2008	Brgy. Paoay, Atok
February 5-12, 2008	Brgy. Paoay, Atok; Brgy. Madaymen, Kibungan
February 13-14, 2008	Brgy. Paoay, Atok
December 17-18, 2008	Sitio Cada, Brgy. Balili, Mankayan; Brgy Madaymen, Kibungan; Brgy Sipsip & Brgy Natubleng, Buguias; Sitio Englandad & Bosleng Brgy. Paoay; Sitio Tuludan, Brgy. Cattubo Atok;
January 15, 2009	Brgy. Paoay, Atok
December 5, 2009	Brgy. Paoay, Atok
December 7, 2009	Brgy. Paoay, Atok

December 25-31, 2011- January 1, 2012	Brgy. Paoay, Atok
Dec 30-31, 2013- January 3, 2014	Atok and Kibungan
January 8-9, 2014	Brgy. Paoay, Brgy Cattubo, Atok; Brgy. Madaymen, Kibungan

Source: Marasigan, R. (2017), p. 31

5. Climate sensitive decisions: selected vegetables and cut flowers

Cabbage Production

Cabbage (*Brassica aleracea L. var. capitatacruciferae*) is a leafy green vegetable grown densely-leaved heads. Closely related to other Cole crops such as broccoli, cauliflower and Brussels sprouts, it descends from *B. oleracea* var. *oleracea*, a wild field cabbage. Cabbage heads generally range from 1 to 8 pounds (0.45 to 3.6 kg), and are found in green, purple and white. Smooth-leafed firm-headed green cabbages are the most common, but crinkle-leafed savoy cabbages are also found. Cabbage is locally known as "repolyo", grown for its firm, compact, round to flat heads. It belongs to a group of cultivated varieties of the species *B. oleracea* called "cole crops". It is the most widely grown crucifer locally. Cabbage is one of the major cash crops of vegetable producers in the Cordillera and one of the leading vegetable crops in the world. Cabbage ranks as one of the most economically important vegetable crop in the highlands[8].

Potato Production

In the Philippines, the most commonly grown variety of table potatoes is Granola while the best processing variety are Igorota. These varieties are being produced in Cordillera Autonomous Region (CAR) and Nothern Mindanao (Region 10). Potato (*Solanum tuberosum L.*), locally known as 'patatas", is grown in 130 countries worldwide including the Philippines. It is grown for its tubers, which are rich in phosphorus and vitamins B1, B2, and C. The major potato production in the Philippines is concentrated in high elevations particularly in Benguet and Mountain Province with a temperature below 21 degrees Celsius (Gonzales et. al, 2016).

Carrots Production

Carrot (Daucus carot L.) is a crop primarily grown for its fleshy root which is used as vegetable. Its root is rich in carotene, a precursor of Vitamin A. It also contains appreciable amounts of thiamine, riboflavin and sugar. Carrots are considered as root crops. In fact, they are one of the most popularly grown root crops in the world. Carrots are also the world's most consumed root crops. It originated from Central Asia with Afghanistan as the primary center of origin. It is one of the most important vegetables commonly grown in the Philippine highlands. The production areas are in Benguet, Mountain Province, Ifugao, Nueva Vizcaya, Cebu, Davao del Sur, Negros Oriental, and Bukidnon. The effect of frosts in Atok, Benguet caused a one (1) percent decline in carrot production in the period January-June 2005 as total

[8] Taken from the document authored by Juanito Nastor, Sr., Verena De Leon and Rafael Cachin of the Bureau of Plant Industry, Department of Agriculture in the Philippines. (undated) http://www.bpi.da.gov.ph/index.php/production-guide/167-cabbage. Accessed on June 28, 2017.

output settles at 16.8 thousand Metric tons.[9] Seven varieties of carrots have been found to perform well under climatic conditions in Benguet State University's farm. These are varieties are Victoria F1, New Kuroda S and G, Tokita Improved, Golden State, New Kuroda Guson, KS Kuroda, and Agro Super Kuroda.[10] Figure 9 below shows the climate sensitive decisions of the agriculture producers or farmers in Atok and La Trinidad, Benguet. Cabbage production is common among the farmers, and they shared that they have tried planting the varieties listed below (Figure 18). They also shared that when during dry season or less rain, Red ball (F1), Justy and Scorpio are typically planted. In anticipation for rainy season, Rare ball, Lucky ball, Mighty ball, Mountain king and Wonder ball are the varieties that they will plant.

Figure 18 Climate sensitive decision for vegetable producers

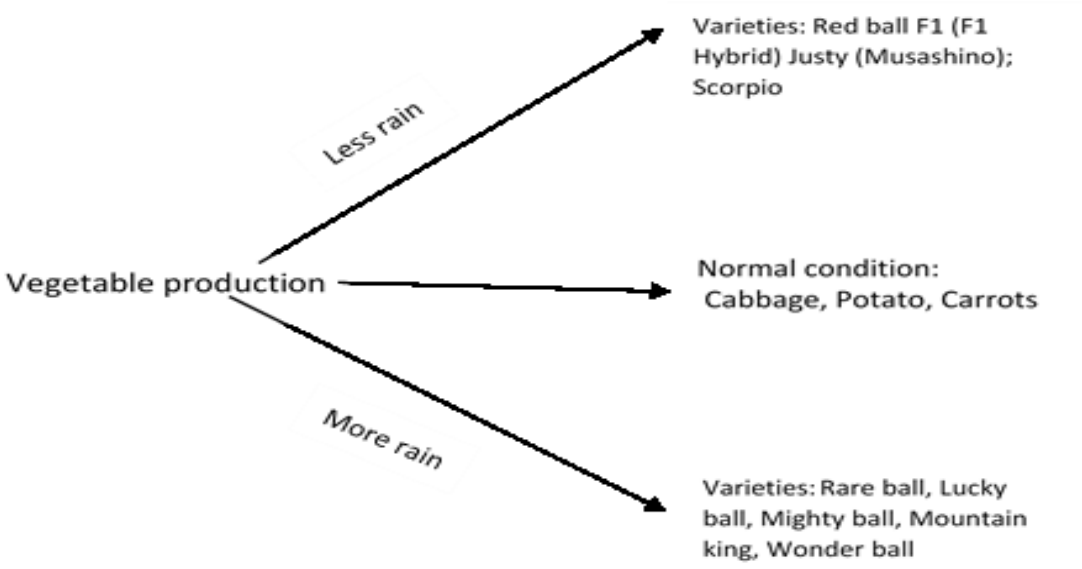


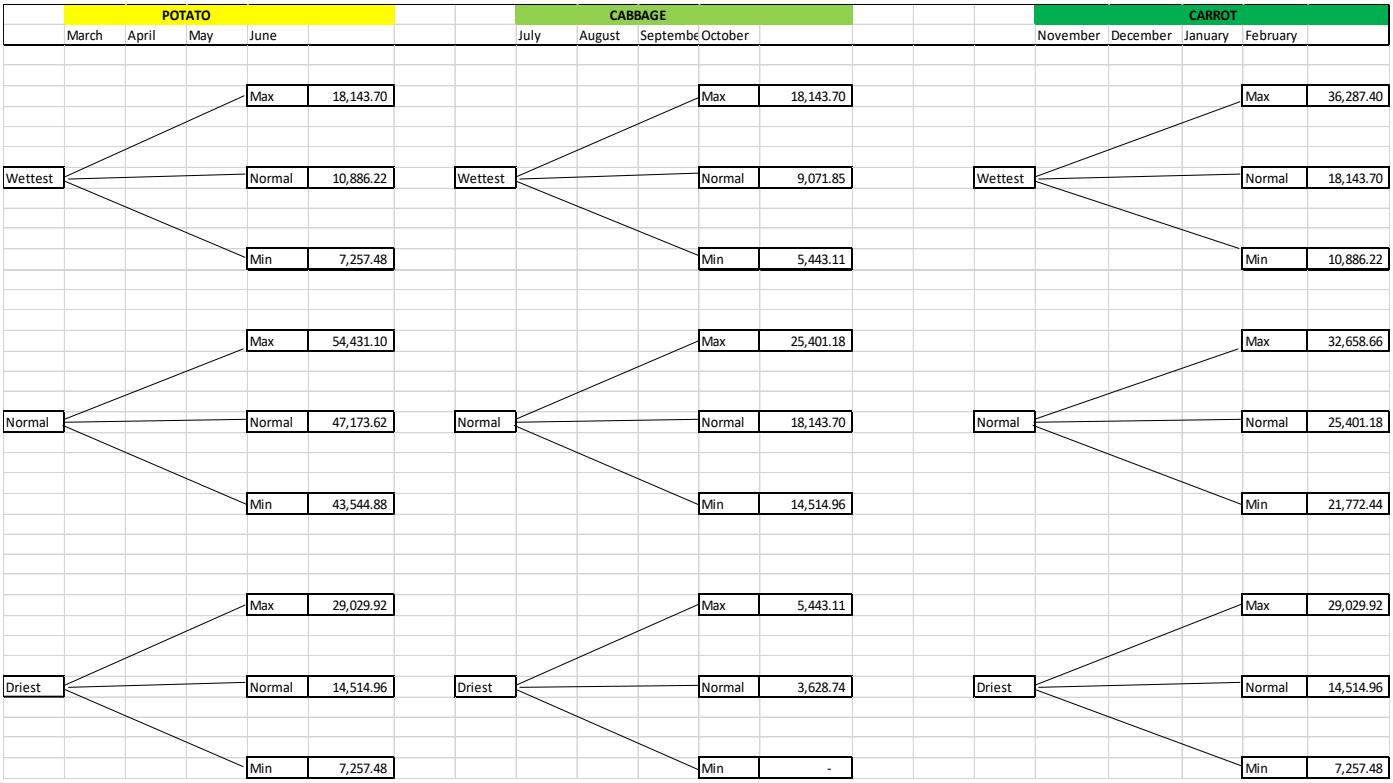
Figure 19 below shows the more complete cycle of planting or production for the selected vegetables in Benguet based on the two sets of focus group discussions conducted in Atok and La Trinindad on May 2017 and last December of the same year. The participants mentioned that they practice crop rotation and their cropping calendar for potato starts on March to June then cabbage from July to October and finally carrot starting November to February. There was no mention of cropping mix among the farmer respondents. For the variety of potato planted, granola and LBR. Granola variety is the choice to be planted during summer season while the LBR is planted on rainy season. For cabbage variety, RB or Rare ball is planted during summer season while the scorpio variety planted during rainy season. For carrot variety, sakata is planted during summer season while sun-long during rainy season. Fertilizers such as Urea and 14-14-14 or Complete is usually applied a month after the planting of

[9] Juanito Nastor Sr and Vivian V. Reyes, Bureau of Plant Industry. (undated)

[10] Joel Long-a, undergraduate Thesis (2004). http://www.philstar.com:8080/agriculture/234742/seven-carrot-varieties-perform-well-benguet

vegetables. This is applied only once per cropping season. While the chicken manure is mixed with the soil usually one to three days before the seed planting. Pesticide application is done twice or thrice a week until two weeks before the harvest. This is the usual practice according to the farmer participants. The yields for different types of rainfall patters were also solicited among the farmer participants. They shared that under wettest conditions, the maximum yield per hectare for potato is about 18 thousand kilos of potato while on minimum yield is about seven thousand kilos. Under the same condition, the normal yield is about 10 thousand kilos of potato. During the driest conditions, farmers shared that the maximum yield is about 29 thousand kilos while the minimum yield is only about seven thousand kilos of potato. From July to October, the farmers shared that cabbage is planted during these months. During wettest conditions, farmers shared that the maximum yield is about 18 thousand kilos cabbage while the minimum yield is only five thousand kilos. During driest conditions, the farmers shared that nothing can be harvested. Carrots are planted in November to be harvested in February, usually to take on the price increases during this time of the year. They shared that the maximum yield will be around 36 thousand kilos while the minimum is 10 thousand kilos during the wettest conditions. During the driest conditions, the maximum yield is 29 thousand kilos while the minimum is about seven thousand kilos per hectare.

Figure 19 Cropping calendar rainfall pattern of the selected vegetables in Benguet, Philippines



Notes: conversion from ton to kilo is, 1=907.185; based on 1-hectare farm size, all figures are on kilos per hectare.

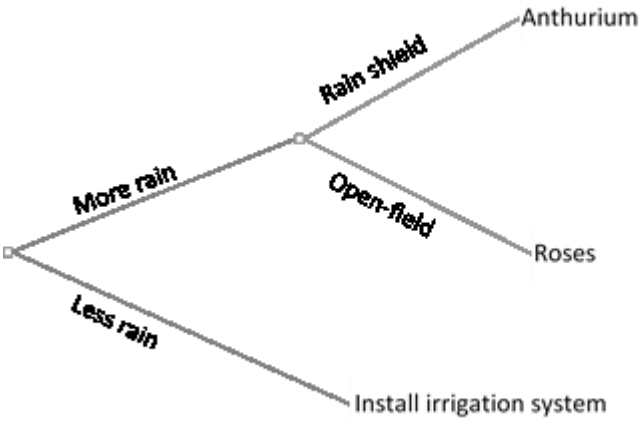
Cut flower Production

Aside from being the "Salad Bowl of the Philippines" for its vegetable production, Benguet Province is also among the major producers of cut flowers in the country. In 2015, around 57 percent of the total production of major types[11] of cut flowers in the country accounts to the province alone.

The FGD participants in La Trinidad revealed rose and anthurium as the most popularly grown cut flowers in the municipality. First harvesting for both flowers starts at 6 months after planting. Next harvesting is done at least once a week for three to five years, when the plant has maximized its productivity. Crop management for rose include pruning to meet the demand for the peak period.

Farming decisions for cut flower, particularly in La Trinidad, are generally not sensitive to climate or weather events because of the continuous nature of production and harvesting. It was shared that some activities were already scheduled ahead of time. For example, harvesting is scheduled at least once a week. Fixed schedule for fertilizer application is also being followed; therefore, any advance climate/weather information that they might obtain does not particularly affect this activity. Moreover, the importance of greenhouses (or locally referred to as rain shield) to cut flower production was highlighted during the discussions. Rain shields are made of plastic or polyethylene sheets roofing that serve as protective covering against extreme weather events, pests, and diseases. More importantly, year-round production is possible through this structure. Investment for a rain shield costs around 1, 600 PhP per square meter, according to the farmer-participants. While rain is essential to cut flower production, too much rain is also damaging. Figure 20 below illustrates the two types of farming cultures decided by cut flower growers upon enter in the venture: rain shield and open-field, to which they determine the type of cut flowers to cultivate. Anthurium is commonly grown in rain shields while roses thrive well in the open fields. During the dry season, irrigation system is installed in the farms to ensure sufficient supply of water.

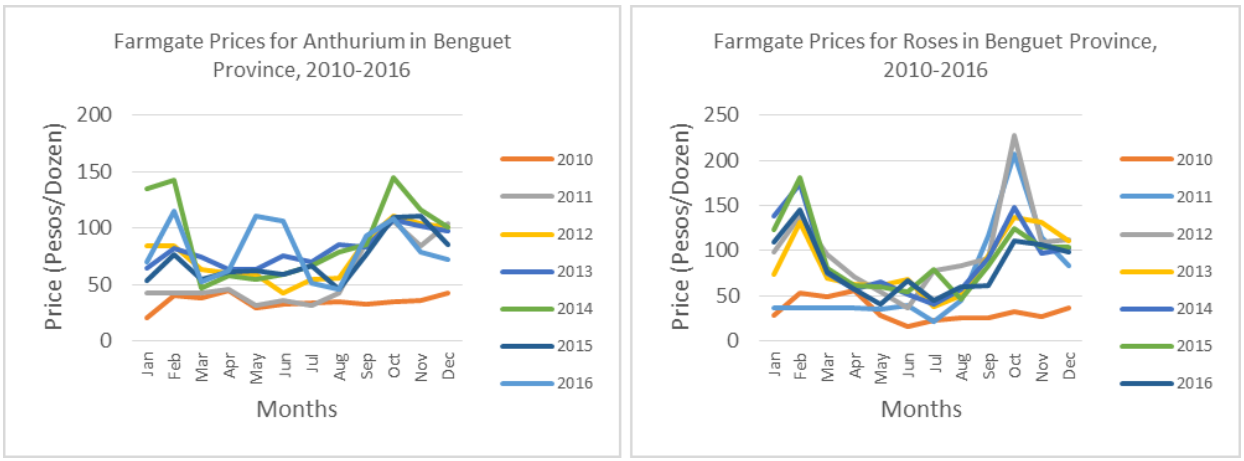
Figure 20 Climate sensitive decisions for cut flower production



[11] Roses, Chrysanthemum, and Gladiola as recorded by the Philippine Statistics Authority (2015)

In terms of prices, cut flowers' increase up to twice its regular price during special occasions due to huge demand. As illustrated in the graphs below, highest prices in the past years are recorded during February and October, month of Valentine's Day and All Soul's and Saint's Day, respectively. To the defense of the producers/traders, peak season is only few days a year compared to the regular days wherein the prices are much lower. The participants also mentioned that they are threatened by the growing importation of cheaper cut flowers in the country. Though it was claimed that locally produced cut flowers are better when it comes to quality, the participants acknowledged that they cannot compete when it comes to packaging of the imported ones.

Figure 21 Farm gate prices of Anthurium and Roses in Benguet, 2010-2016



Source of basic data: PSA Country Stat Philippines, Cut flowers: Farm gate Prices by Region and by Province

The main issue faced by the growers is the increasing price of farm inputs which hurdles expansion. It was estimated that around sixty percent (60%) of their revenue comprise the cost of farm inputs. Subsidies on the prices would be helpful, according to them. Another one is the lack of new varieties in the market. Development of new technologies for cut flowers is slightly stagnant over the past decades as it was not prioritized by the government unlike rice and corn. PSA (2008) considered the introduction and improvement of cut flower varieties as the backbone of the industry and cited the importance of breeders in the production of planting materials.

5.1 Critical decisions influenced by climate risks

El Niño and La Niña

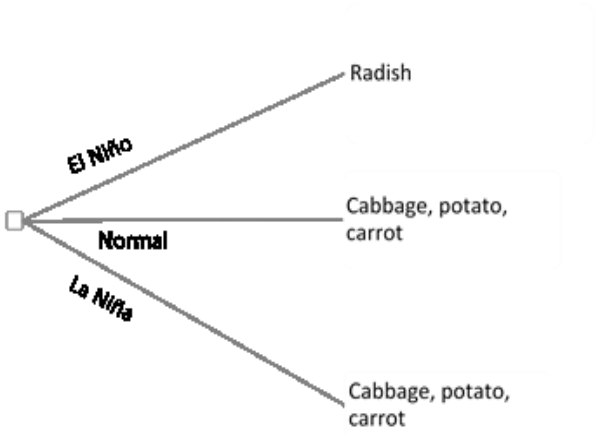
Benguet is listed among the provinces that have experienced dry spell and drought brought about by El Niño in the previous years. Analysis of the annual temperature in Baguio Synoptic Station indicates an increasing trend. This is based from the difference of the actual data from 1949 to 2015 and the average of the 1981 to 2010 temperatures. A temperature increase of 0.48°C was observed during the last 65 years. The highest increase in temperature is evident during the period from 1982 to 1983 and 1995 due to the El Niño phenomenon (PAGASA, 2017). PAGASA added that changes in rainfall pattern are associated with changes to tropical cyclone activity in the western equatorial Pacific, the strength of the monsoon, changes in the onset and/or termination of monsoon rains and the ENSO phenomenon. Analysis of the annual rainfall in Baguio shows an increasing trend based from the difference of the actual data from 1950 to 2013 and the average of the 1981 to 2010 rainfall values. Reductions in rainfall are evident during El

Niño years (i.e. 58-59, 82-83 97-98, etc.). While increase in rainfall during La Niña years (i.e. 72, 74, 08-09, etc.)

Some of the measures implemented to mitigate the effects of this kind of climate risk include changes in timing of planting and crop shifting, according to farmer-participants. As illustrated in the figure below, vegetables such as cabbage, potato and carrot are most commonly grown during normal and rainy seasons but some farmers opted to shifting to a more drought-tolerant crop during El Niño which is radish.

Changes in location of crops is also practiced by farmers who own additional parcels of land in other areas. Moreover, a few shared that they use trucks in transporting water from source to their farms thus adding costs and over-all burden on their part. It was also mentioned that farmers requested for tree seedlings from the Department of Environment and Natural Resources (DENR) for them plant in some areas in their barangay.

Figure 22 Climate sensitive decisions during El Niño and La Niña for vegetable production



Frost

Frost was considered as a regular and accepted phenomenon in certain municipalities of the province, until recently when its occurrence and perceived impact gained more interest from social media, traditional news outlets, and the general public. As of now, there is no available frost forecast or advisory in the country. Marasigan (2017) characterized the occurrence of frost in some areas in Benguet. She explained that the areas with high risk have high frequency of the cloudless nights with temperatures falling below within a minimum temperature threshold. This information is relevant as cloud cover is one of the major factors for radiative frost occurrences. During the passage of a cold surge, highly elevated mountainous areas with clear skies like Atok and Kibungan are more prone to frost. Aside from meteorological conditions, the topography plays a vital role in frost formation. Elevation and morning potential insolation (MPI) have the most influence in frost risk. The seasonal variability of the solar radiation in the morning contributes to the soil energy balance, local diurnal wind development and risk of radiative frost (Marasigan, 2017).

Some of the farmers relied on indigenous knowledge when it comes to frost forecasting. It was believed that a clear sky with no wind movement in the afternoon is a sign that a frost episode will occur at night or early morning. When frost happens, farmers seem to think that there is nothing that can be done about it. Relying from their past experiences, only small portions of the farms are affected and crops usually recover. Additionally, and contrary to what the national news have been reporting, there is an impression among locals that frost does not affect the supply nor the prices of vegetables in the market.

Figure 23 Climate sensitive decisions during occurrence of frost

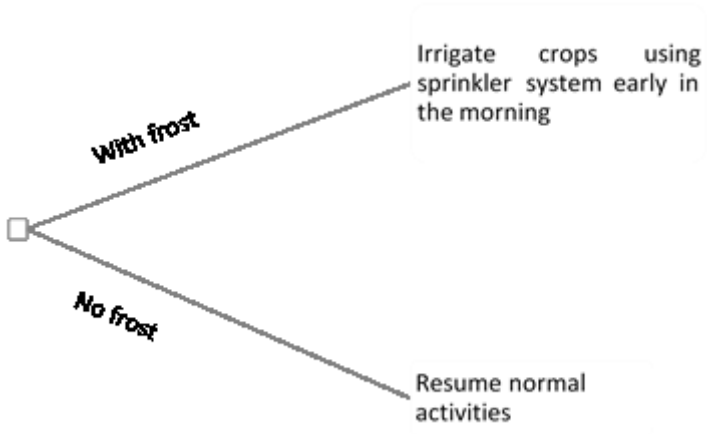


Figure 23 above illustrates the farming decisions considered by farmers in Atok in the occurrence as well as absence of frost. In the event of night frost, experience has taught them mitigation measure such as irrigating the fields early in the morning through sprinkler system to minimize damage. Early indications of frost would also require prepositioning of irrigation equipment. On the other hand, no frost occurrence only means resumption of normal activities for the farmers.

Furthermore, plant varieties that are resistant to cold weather are already being cultivated in the area. Some varieties of cabbage, carrots and radish that are planted are normally resistant to cold weather and even on frost. The farmers also shared that changing crop varieties and crop type, as part of crop rotation practices, are common in the area. The reason is not primarily due to frost but because it was believed that it will help improve the quality of the soil and break the cycle of pests. Although there were sentiments about the middlemen or disposers and retailers capitalizing on frost events to increase prices in the major urban markets, the buying price from farmers in the Benguet trading post is claimed to be unaffected.

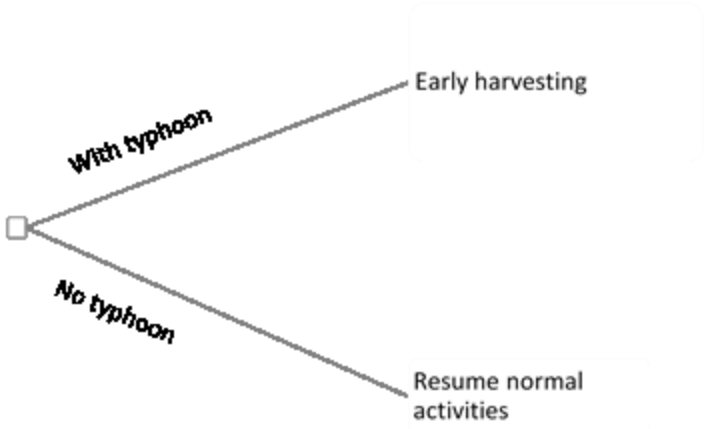
Typhoons

Farmers. Among the different climate risks, typhoon was identified by the farmer-participants as most damaging and unmanageable. The most recent strong typhoons experienced in the province are TY Lando in 2015 and TY Lawin in 2016 with estimated damage to agriculture amounting to 188 million pesos and 5 million pesos, respectively. It was also observed that the intensity of recent typhoons were stronger and more destructive compared to decades ago. Typhoon occurrence patterns have also changed from month of July to October.

The farmer-participants shared that they have experienced crop failure especially after typhoons. Fagyan (2017), citing a study of Benguet State University, revealed that damage to vegetable crops due to typhoon ranges from 80 to 100 percent as most plants need to be replaced. Other risks include rotting of crops, breaking of stems and twigs, or totally flattening of plants into land. A key informant described farming enterprise as a “gamble” on part of the farmers because despite the risks involved, farmers still choose to plant on the anticipated typhoon season. According to them, past experiences have already

taught them mitigating and coping measures. One of these, as shown in the figure below, is early harvesting. Some of them manage to harvest whatever they can before the typhoons come than have it destroyed and lose entirely. It was reported that early harvest causes the price of vegetable to drastically dip before the typhoon because of the sudden increase in supply. Additionally, farmers also learned to adjust their planting season in such a way that the growing stage (or flowering stage for some crops), which is the most critical stage of crops, would not fall under the typhoon period.

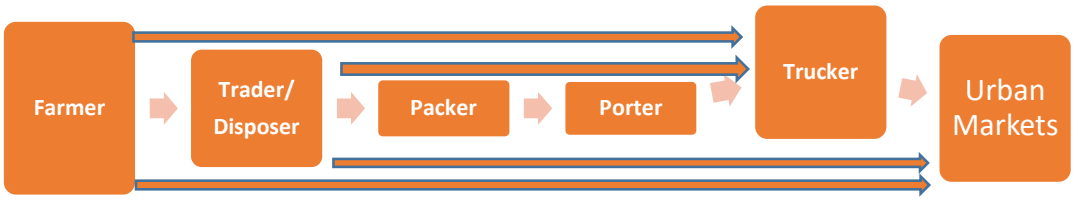
Figure 24 Climate sensitive decisions before occurrence of typhoon



Traders. Most produce coming from the vegetable producing municipalities in Benguet pass through La Trinidad before they are distributed to several market areas outside the region. The La Trinidad Vegetable Trading Post (LTVTP) serves as the centralized venue and major trading outlet in the province. The municipality of La Trinidad is currently managing the trading post and generates income through revenues collected from the management and operations of the post.

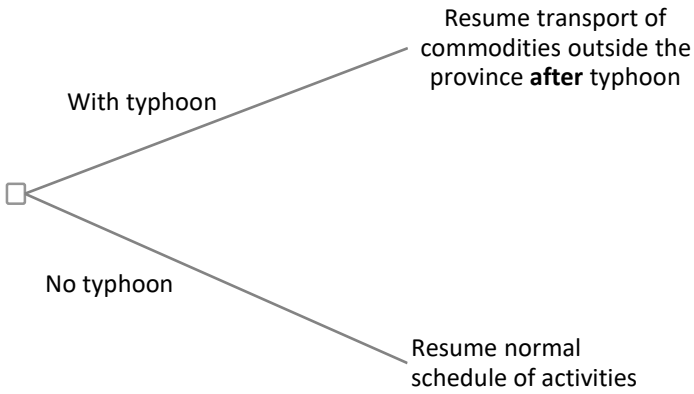
The three major marketing players at the trading post are farmers, traders/disposers and truckers. Common flow of produce handling in the trading post is illustrated in the figure below. Upon arrival of farmers, traders (disposers/vegetable dealer) will then inspect the produce and decide to buy. The produce will then be handled by packers who are in-charge of cleaning, sorting and packing. Porter will carry and transfer the produce to truckers hired by the traders. Truckers provide invaluable service as they transport the commodities to and establish trade links with distant urban market wholesaler and retailers in Luzon such as Metro Manila, Pangasinan, Zambales, Bulacan, Laguna and Batangas. Alternatively, some farmers and disposers sell directly to truckers. Exceptional farmers and disposers with trucks of their own can transport produce and sell directly to select urban markets. Trade relationships built-up over the years sometimes allow truckers to transport produce on consignment basis.

Figure 25 Supply chain of vegetables at LTVTP



On the average, 300 truckers from the trading post transport commodities outside the province on a daily basis, according to the market supervisor. This number drops significantly when there is a typhoon as majority (around 75%) of the traders prefer to delay transporting commodities and resume after the typhoon (see figure below). Human safety is still the main consideration of traders when there are seasonal climate or hydrometeorological risks. Numerous road closures which may disrupt the delivery of produce is also considered. When an issued typhoon advisory will hit the planned delivery area, some traders also transfer to other market areas that are not affected. It was also mentioned that some of the traders reduce the quantity they purchase from farmers during typhoons to minimize postharvest losses.

Figure 26 Climate sensitive decisions undertaken by traders and truckers after typhoon



The general commodity supply and demand situation in the trading post usually determines price movements, with the dynamic interaction and information exchanges among disposers, truckers and urban wholesalers playing a big part in price setting. Farmers, particularly smallholders, who sell to traders/disposers/truckers just take what they can and have less leverage in price setting.

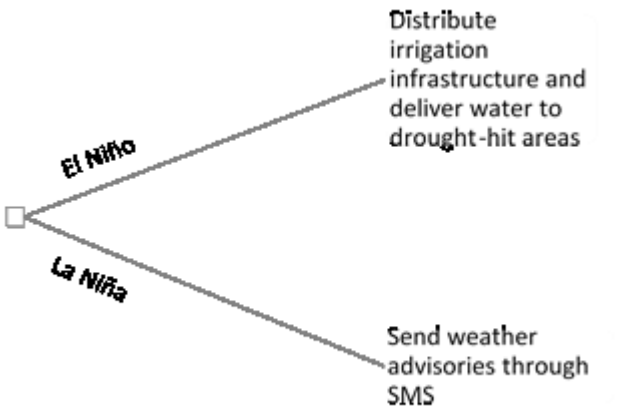
Traders/disposers and truckers in the trading post were considered as the dominant entities when it comes to controlling prices as validated by key informants. The structure of trading system allows them to dictate prices while farmers are left with no choice but to sell their produce sometimes even at below breakeven prices. This imbalance in bargaining leverage gives undue advantage to traders and possibly opens up avenues for price manipulation. In theory, traders can agree to halt buying for a while and wait for the supply to increase and prices to go down, or cease buying operations during instances of natural calamities or seasonal climate shocks. There is no clear response when asked about local government's intervention to control this kind of situation.

Government. The local government of La Trinidad is in partnership with the Agricultural Training Institute (ATI) when it comes to capacity building activities for technical workers and famers in the municipality, according to the MAO. Technical workers are invited to attend trainings and come up with project proposals for each commodity that they were assigned to. The LGU also conducted Farmer Field School (FFS) which include topics on climate change. Moreover, the LGU has been introducing production programming to farmers. One of the participants also claimed that he learned how to perform a simple record-keeping from a training conducted by the local government. Some of the farmer-participants have also attended risk management trainings. The LGU have also established a Local Disaster Risk Reduction Management Office (LDRRMO) with a designated officer. Before a typhoon, the officer sends an advisory through text message containing forecasts and expected conditions to residents of the municipality. According to an informant, this is very helpful especially to the farmers.

After the onslaught of recent destructive typhoons, the province received damage aid from the Department of Agriculture (DA). According to reports, the aid was used to help vegetable farmers recover by providing them with certified seeds, farm equipment, water hoses and sprayers. On the previous dry spell experienced in the province, the provincial government and the National Irrigation Administration have subsidized the construction of small farm reservoirs in several drought-hit areas. Delivery of water to farms were also done. The municipal agriculturist, in an interview with Rappler, said that water deliveries have kept the cut-flower industry stable in La Trinidad.

Figure 27 below reflects the key activities done by the local government as briefly discussed above in relation to climate risks.

Figure 27 Climate sensitive decisions undertaken by the Local Government Units



Academe. Through the establishment of Climate Smart Agriculture Center (CSAC), the Benguet State University (BSU) continues to develop and introduce agricultural technologies that help reduce the impacts of climate change to farmers in the province. These technologies include an in-field water harvesting tank which would supply water during drought; a structural windbreak to control strong winds that damage crops; reinforced vegetable terraces to prevent soil erosion; and rain shelter to protect crops from heavy rainfall and too much heat (Bartolo, 2016). These technologies were developed as part of a disaster and climate change-related project in partnership with the USAID and World Food Program.

Trainings for farmers were also conducted by the university through its Research and Extension Office to enhance the capacity of farmers to implement sustainable agriculture practices and adopt strategies that will help them cope with the impacts of climate change.

5.2 Use and Sources of Climate Information

The participants in the focus group discussions in La Trinidad and Atok were in unison in saying that weather/climate is major factor taken into consideration in their planning and crop decision making. Probing further, it was rated high in terms of significance of its value or contribution to their farming activities which then translates to the importance of weather information to farming decisions that include selection of crop variety, choice to purchase or build infrastructure (eg. greenhouse or rain shield), and schedule farming activities like planting and harvesting, as enumerated by the participants. A more advanced information on seasonal climate forecast is also very important in their over-all agricultural production activities which also covers the early preparation stage (eg. securing the greenhouses, do necessary repairs, and create farm canals). According to them, at least a week advance forecast would help them prepare and plan the production very well.

With regard to climate forecast information in relation to their production decisions, the onset of rainy and or dry season was ranked first. They consider this as the most important information in their farming activities. Amount of rainfall was ranked second, they opined that this another information that they need especially that they grow vegetables which is dependent and very sensitive on amount water. Duration of the rainy and or dry season is ranked third by the participants while estimated number of days of the rainfall season is ranked fourth. They shared that the information they hear from the Philippine forecast seems not really applicable in their place.

In terms of source of weather/climate information, the following are in order of importance; radio, television, and cellphone short message service (SMS) from the National Disaster Risk Reduction and Management Council (NDRRMC). Internet, particularly Facebook as a source of climate information was also mentioned by some of the participants. They also received climate information from their fellow farmers and from their organization leaders. On gender roles, the woman (*Nanay*) in the family usually acquires the information from the sources mentioned above then relays it to the man (*Tatay*) and rest of the family.

The participants also shared some traditional beliefs such as the presence of migratory birds locally known as “Kiling”, a tiny red-necked and long legged bird, identified by its “killing-kiling-kiling” chirp is often heard only once a year during the month of November. A typhoon usually follows by one day and one night the coming of the “killing”. The presence of the “killing” bird marks the end of the rainy season and signals the beginning of the dry season. Another seasonal bird known as the “Siyet” or “Indokit” emerges in the month of December. This season is characterized by isolated rain showers and gusty winds. In Benguet, this signals the beginning of the cold season, “andap” or the “angchap”. In jest, the participants also expressed that these birds are not any more accurate in predicting the weather, thus also are affected by climate change.

Among the products and services offered by Philippine Atmospheric Geophysical and Astronomical Services (PAGASA), annual seasonal climate forecast and tropical cyclone warning are more popular to the participants. These type of forecast and warning were rated to be somewhat useful according to the participants. On a consensus, they still believed that the reliability of traditional method of forecasting climate condition depends on the farmer. Moreover, other weather-related products such

as Monthly Weather Situation and Outlook, Regional Agri-weather Advisories, Farm Weather Forecasts and Advisories, Philippine Agro climatic Review and Outlook and Philippine Agri-weather Forecasts are not known to the participants.

When sought for views about whether participants are satisfied with the climate information they obtained from the sources previously mentioned, they shared that there is a need to improve on weather information. The participants expressed that they hear about the seasonal climate information provided by PAGASA but not confident on the forecast given. It was added that those information needs to be more accurate so that the use can be maximized. Given the unique microclimatic condition of the province, majority of the participants also expressed the need to have a localized forecast from Philippine Atmospheric Geophysical and Astronomical Services (PAGASA). Probing on the relevance of this climate information, they still rate it as moderately relevant, the fact that they still await and expect for this climate information.

Suggestions for a better dissemination of information include distribution of printed pamphlets, utilization of social media, through local officials, and local radio. The most preferred medium is the SMS (short message services). When it comes to willingness to pay for information, the participants prefer it to be free but also willing to pay up to 2.50 pesos per SMS.

5.3 Exploring Price Trends and Weather Events

Wholesale buying price for vegetable at the La Trinidad Vegetable Trading Post (LTVTP) depend on the volume of supplies arriving and demand of buyers from different markets in Metro Manila and other parts of Luzon. Figures 20-24 below illustrate the trend of weekly and monthly prices of selected vegetables over the past years (2012-2016) recorded at the widely utilized trading post in Benguet. The seasonal trend in wholesale buying prices for selected vegetables, as shown in figures below, indicate that the highest prices are obtained during the second half of the year wherein extreme weather events such as typhoons and monsoon rain usually occur. Limited supply due to damages in crops as well as interrupted delivery system during this season results to increase in prices. Meanwhile, lower and more stable prices can be observed in the identified harvesting months of farmers, usually in March and April. During this period, vegetable market is oversupplied since farmers are eager to immediately dispose of their produce.

In general, erratic price movements are shown for cabbage and carrots while a relatively stable price trend is demonstrated for potato. Price of cabbage is relatively higher during the months of July to December. Highest price was recorded in August 2015, after Typhoon *Ineng* onslaught. Price of carrots starts to increase in May and fluctuates for the rest of the year. Similar to cabbage, the sudden spike in prices can be attributed to the occurrence of typhoons; TY *Egay* in 2012 and TY *Lawin* in October 2016. For the prices of potato, it can be observed that the highest price usually occurs during the first quarter and last quarter of each year. This can be ascribed to higher demands during these seasons.

The following are monthly observations and records[12] on the wholesale buying price trend of vegetables in LTVTP:

[12] Compiled from the Monitoring Reports of the Agribusiness and Marketing Assistance Division (AMAD) of Department of Agriculture – Cordillera Administrative Region

- Spike in the prices of vegetables for the first week of January can be attributed to the decrease in supply delivered to the market because of the concluded holiday season. Prices tend to stabilize for the rest of the month.

- For February, there is a slight increase in the prices during last week of the month which is caused by the high demand from tourist and visitors who attend the Panagbenga Festival in Baguio City.

- Oversupply in the market is common during the month of March which then results to decline in prices. A slight increase in prices during the last week and early April can be attributed to increasing demand due to approaching Holy Week celebration. Generally, prices for the month of March and April are relatively lower because this is the harvesting season for farmers who have planted in December and January.

- Prices of vegetables start to increase during the month of May. There is a limited supply in the market since this month is usually the start of the planting season for farmers. Another reason for the increase is the frequent rainfall which causes damage to vegetables especially cabbage and carrots.

- For June, most prices of vegetables increase especially for carrots and Chinese cabbage is caused by the unstable volume of deliveries to the trading post. Moreover, some farmers are still on the planting stage while vegetative stage for those who planted last month.

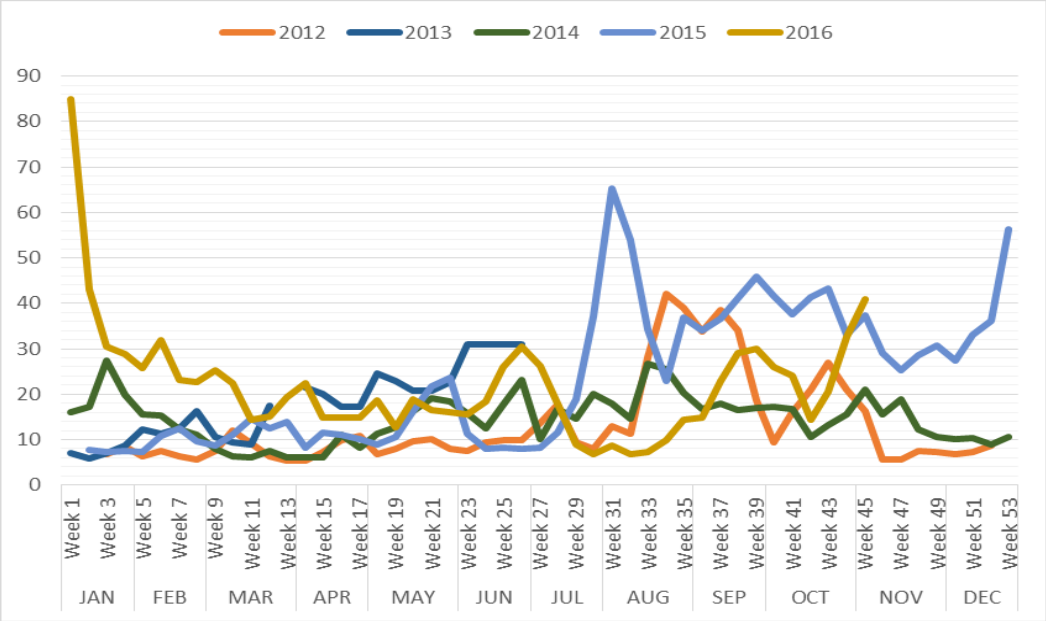
- Most of the prices of vegetables increase in July due to the continuous rainfall in the province. Though there is enough supply at the trading post, the problem is that most of the vegetables that arrive at the post are damaged due to the exposure to excessive rain. Slow queuing, some even spent the whole to be accommodated at the post, also became a problem. In 2015, Typhoon *Egay* (July 5-6) and monsoon rain (19-days rain) had caused an increase in prices of vegetables which is reflected in the figures below. There were also reports of road cuts and landslides on some road networks. On the same period in 2016, a typhoon named *Butchoy* had also affected the province.

- The consistent spike in the prices of vegetables during the month of August for the past years was caused by the occurrence of excessive rains and typhoons. In 2012, Typhoon Gener and Typhoon *Igme* caused the unstable supply of commodities at the trading post. In 2013, due to heavy rains, road closure advisories were issued. The sudden dip in the prices in the later part of the month of this year is because of the oversupply and decrease in orders of buyers. In 2015, strong and continuous rain brought by Typhoon *Ineng* (August 20-24) caused major damage to vegetables and major road networks in the province hindering the delivery of farmers. In 2016, some roads were not passable due to continuous rainfall. Landslides in some areas were also reported.

- Prices during the months of September and October start to drop. Some commodities had recovered from the damage brought by past typhoons and excessive raining thus resulting to increase in the volume arriving at the trading post. The increase in prices in the last week of October 2016 to early November is due to Super Typhoon *Lawin* which had caused major damage to agriculture sector in the province.

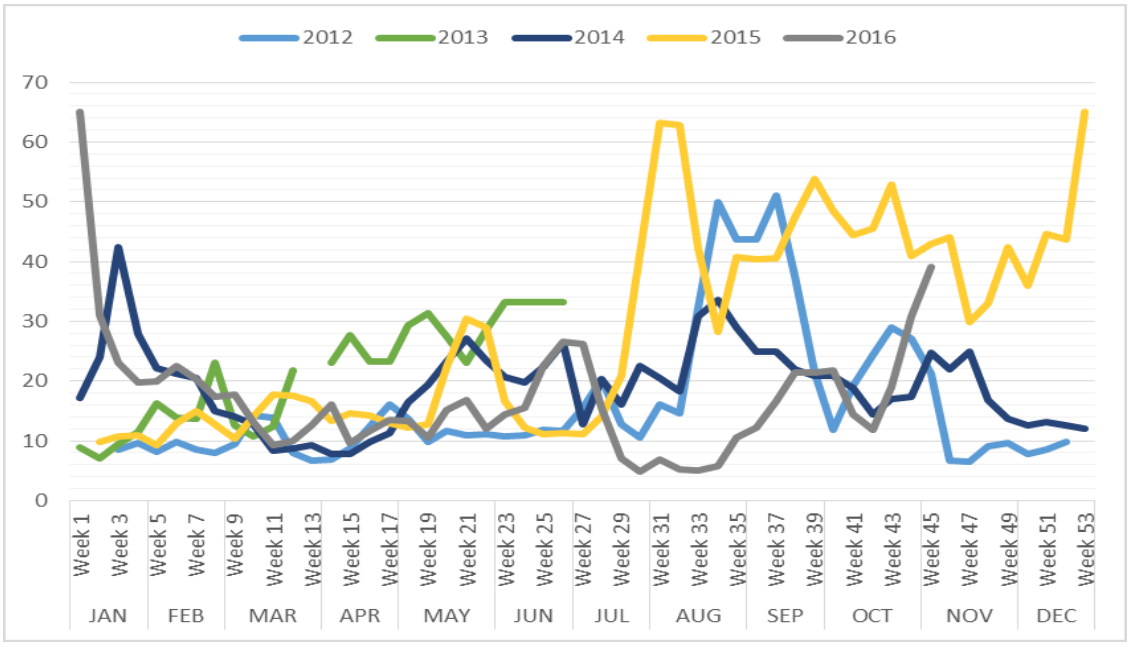
The erratic movement of prices, as demonstrated below, is mainly attributed to unstable supply at the trading post. The occurrence of extreme weather events usually contributes to this. During a strong rain or typhoon, farmers do not usually harvest while trading at the post become very slow. Processing/packing and trading are also seriously affected especially those packing at the parking areas without shed. Transporting was also affected by strong rains due to floods along the national highway, Metro Manila and other major destinations while many traders do not want to risk their business. Another reason that causes supply instability, as determined on the monitoring report by DA-AMAD, is the "one time planting and harvesting" custom by farmers. Majority of farmers in the locality do not practice coordinated or harmonized production programming which means that they have independent decisions regarding the area to be planted, crop choice, cropping calendar: when to plant, when to harvest and deliver to the market.

Figure 28. Weekly Average Wholesale-Buying Price of Cabbage Rareball at the La Trinidad Vegetable Trading Post, 2012-2016



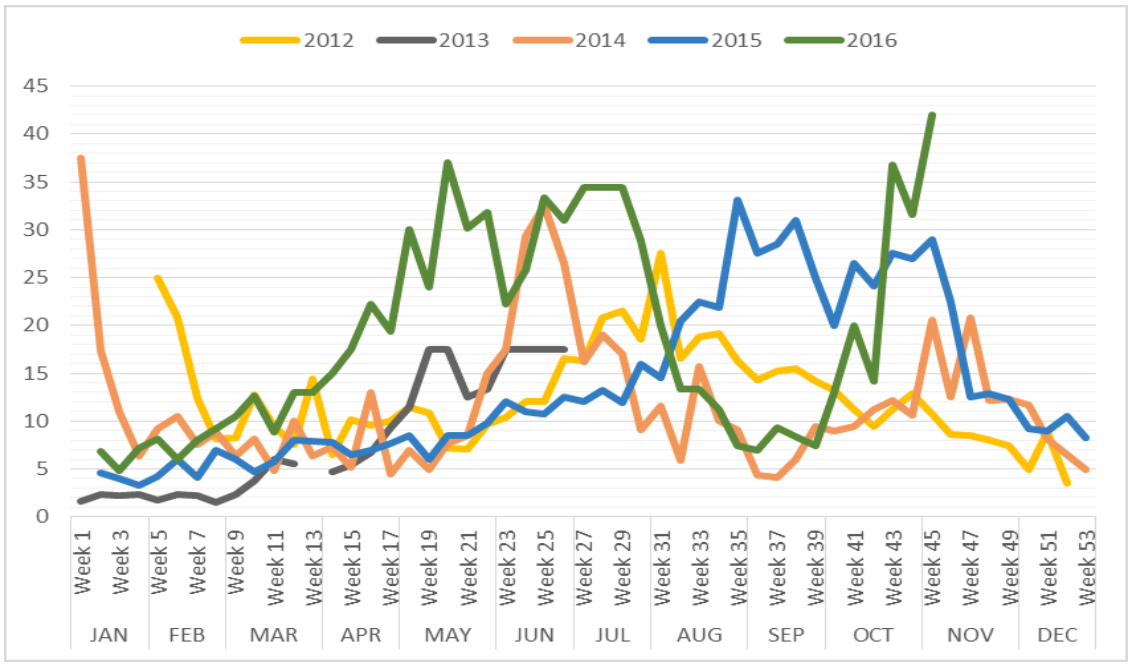
Source of basic data: Department of Agriculture – CAR, Agribusiness and Marketing Assistance Service Division (AMAD)

Figure 29. Weekly Average Wholesale-Buying Price of Cabbage Scorpio at the La Trinidad Vegetable Trading Post, 2012-2016



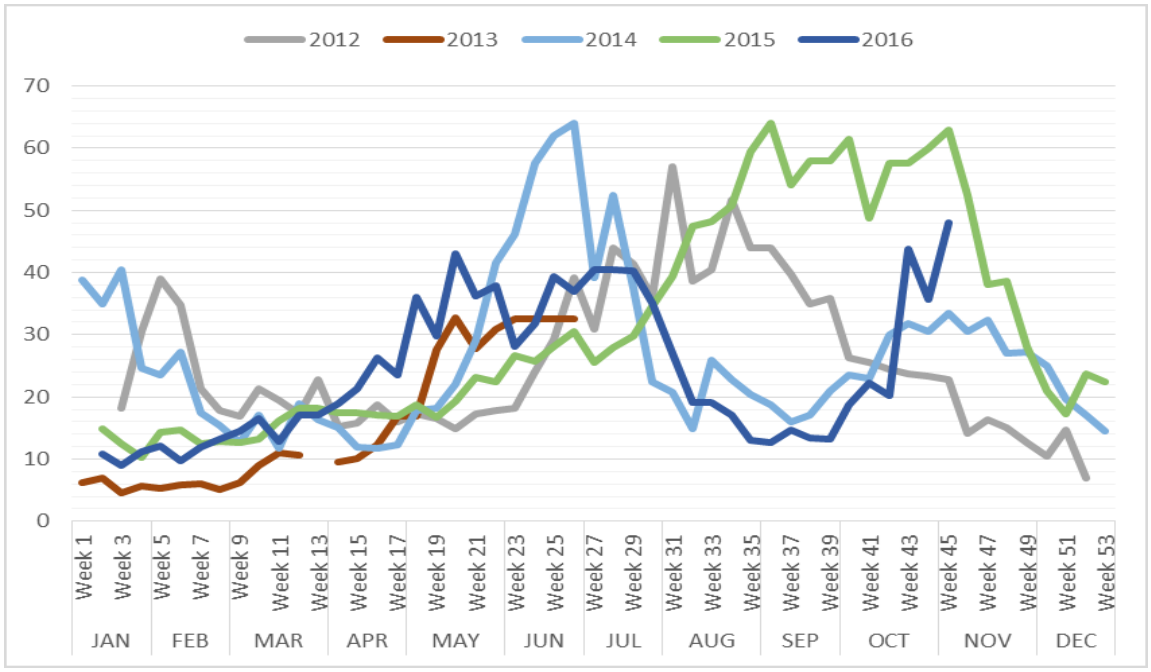
Source of basic data: Department of Agriculture – CAR, Agribusiness and Marketing Assistance Service Division (AMAD)

Figure 30. Weekly Average Wholesale-Buying Price of unwashed Carrots Big at the La Trinidad Vegetable Trading Post, 2012-2016



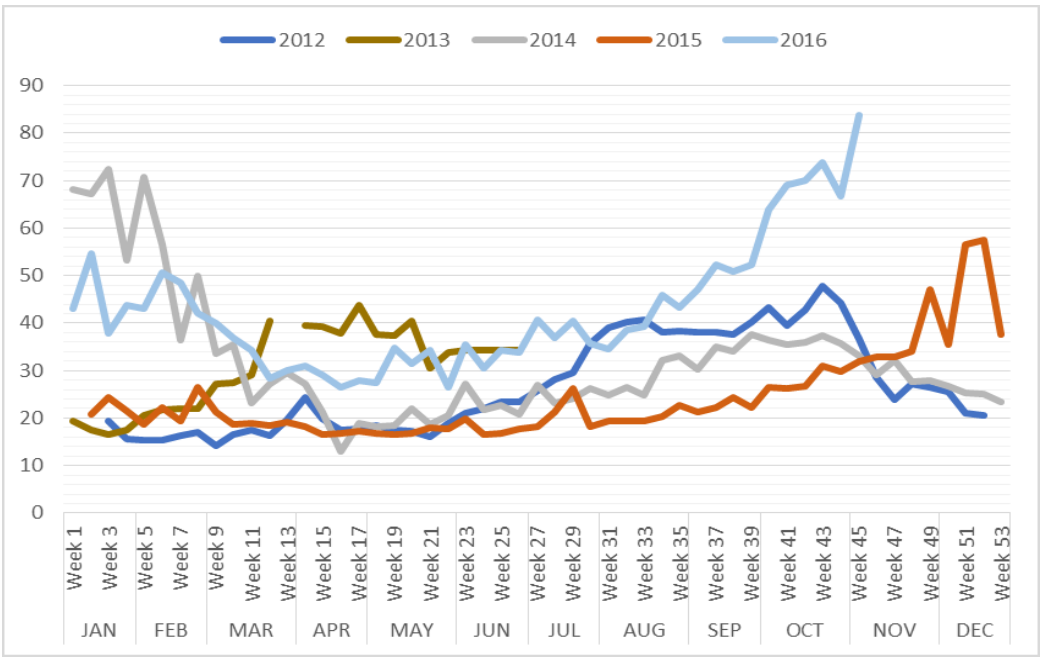
Source of basic data: Department of Agriculture – CAR, Agribusiness and Marketing Assistance Service Division (AMAD)

Figure 31. Weekly Average Wholesale-Buying Price of unwashed Carrots Medium at the La Trinidad Vegetable Trading Post, 2012-2016



Source of basic data: Department of Agriculture – CAR , Agribusiness and Marketing Assistance Service Division (AMAD)

Figure 32. Weekly Average Wholesale-Buying Price of Potato (Super XL) at the La Trinidad Vegetable Trading Post, 2012-2016



Source of basic data: Department of Agriculture – CAR, Agribusiness and Marketing Assistance Service Division (AMAD)

6. Summary and concluding points

Study visits were conducted in the municipalities of Atok and La Trinidad, Benguet, two leading producers of vegetables and cutflowers in the country. Of particular interest were decision-making processes as they relate to the occurrences of frost in Atok over the past years, and the impact seasonal climatic events on production and market risks. Hydrometeorologic hazards like excessive rainfall and landslides also give impetus to examining the supply chain of produce from Benguet to markets in Metro Manila and other major cities in the Philippines. The researchers conducted series of focus group discussions (FGDs) among farmers representing producers of cut flowers, cabbage, potato and carrots among others; agricultural traders represented by disposers, truckers; and government support service providers covering provincial and municipal agriculturists, and agriculture technicians.

As shared in group discussions and informant interviews, agriculture producers practice crop rotation for three cropping seasons in a year. The typical cropping calendar consists of planting potato from March to June, cabbage from July to October, and carrot from November to February. Vegetable growers change cropping sequences and plant certain varieties depending on expected seasonal climate. During the dry season or when there is less rain, cabbage varieties Red ball (F1), Justy and Scorpio are typically planted. In anticipation of the rainy season, rare ball, Lucky ball, Mighty ball, Mountain king and Wonder ball are instead grown. This reflects varietal preference depending on the season. In the case of cut flower growers, rain shield and or open-field are crucial to which they determine the type of cut flowers to cultivate. Anthurium is commonly grown in rain shields while roses thrive well in the open fields. During the dry season, irrigation system is installed in the farms to ensure sufficient supply of water.

During frost occurrence, some of the farmers then rely on indigenous knowledge. They believed that a clear sky with no wind movement in the afternoon is a sign that a frost episode will occur at night or early morning. Farmers generally think that nothing can be done to stop the occurrence of frost. From farmers' past experiences, only small portions of farms are affected and plants eventually recover. Before the occurrence of a typhoon, farmers resort to early harvesting to minimize crop losses.

Most vegetable producers in Benguet sell their produce at the trading post in the provincial capital. Cutflower producers and traders, on the other hand, transport and sell their produce directly to markets in Metro Manila. The three major marketing players at the vegetable trading post are farmers, traders/disposers and truckers. Disposers inspect and grade the produce, while truckers provide invaluable service as they establish trade links with urban market wholesaler and retailers in Luzon such as Metro Manila, Pangasinan, Zambales, Bulacan, Laguna and Batangas. Most vegetable farmers sell to trader/disposers, some sell directly to truckers. Exceptional farmers and disposers with trucks of their own can transport produce and sell directly to select distant markets. Trade relationships built-up over the years sometimes allow truckers to transport produce on consignment basis.

The general commodity supply and demand situation in the province's vegetable trading post usually determines price movements, with the dynamic interaction and information exchanges among disposers, truckers and urban wholesalers playing a big part in price setting. Vegetable farmers, particularly smallhold growers, who sell to traders/disposers/truckers just take what they can and have less leverage in price setting.

Safety is still the main consideration of traders and truckers when it comes to assessing risks. Also considered are disruptions in the transport and delivery of produce due to numerous road closures in times of calamity. When a typhoon is projected to hit planned delivery areas, some traders move produce to other market areas that are not affected. It was also mentioned that some of the traders reduce the quantity they purchase from farmers during typhoons to minimize postharvest losses. The LGUs have also established a Local Disaster Risk Reduction Management Office (LDRRMO) with a designated officer. Before a typhoon, the officer sends an advisory through text message containing forecasts and expected conditions to residents of the municipality. According to an informant, this is very helpful especially to local farmers.

Localized weather information and seasonal climate forecast are needed. These are very important inputs in the decision-making and over-all agricultural production activities of the farmers. Farmers shared that at least a week of advance local forecast would help in preparing and planning for production operations. Weather/climate information are sourced from different media. The following are sources of information in order of importance; radio, television, and cellphone short message service (SMS) from the National Disaster Risk Reduction and Management Council (NDRRMC). Internet, particularly Facebook as a source of climate information was also mentioned by some of the participants. They also received climate information from their fellow farmers and organization leaders.

Looking at the decision-making contexts, patterns of information exchange, and factors influencing information use are important elements in the development of more effective tools and processes for supporting climate sensitive decisions. A more localized climate forecasts is a clamor for many of the farmers and traders interviewed. More efforts to provide and enhance the delivery of relevant climate information will benefit a wide array of agricultural stakeholders. The roles of PAGASA, local governments and the academe, among others, are relevant in identifying existing information networks, and in generating, sharing, and enhancing climate information at different stages of information dissemination. The timing, accuracy and local applicability of climate information matters to farmers and other decision makers especially in their day to day activities.

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