BIBLIOGRAPHY

DAYUWAN, EDRALYNE B., APRIL 2012. Documentation on the Impact of Climate Change to Mango Production and Coping Mechanism Employed at Dalupirip Itogon, Benguet. Benguet State University. La Trinidad, Benguet.

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ABSTRACT

This study was conducted in mango producing area of Dalupirip, Itogon, Benguet, to document the climatic changes for the last 20 years. Forty mango producers were interviewed to document the awareness, local knowledge, and observations of farmers, the effects of climate change in aspects such as demographic profile of the study, production practices, incidence of pest and diseases and other production problems, and strategies or coping mechanism employed.

The findings showed that all farmers at Dalupirip, Itogon, Benguet depend on farming and climate change has an effect on mango production in the past 20 years in terms of weather and climatological data. Climate changes are experienced by the respondents although not aware of the word, but describe it by their own understanding regarding the phenomena. Moreover, mango producers adapt the climatic change that arises in the area. Farmers perceived a positive and negative effect of climate change to mango production.

Problems encountered by the farmers include were environmental factors such as pest attacking the plant, bad weather condition such as typhoon and storms.

It is therefore recommended that any concerned agencies should train and/or teach farmers the strategies and or introduce integrated pest management on how to cope up with these arising pests and diseases, and most especially, the phenomena observed. Moreover, farmers should minimize the usage and/or application of inorganic fertilizers and instead practice organic agriculture.

INTRODUCTION

Rationale

Mango is one of the most popular and important fruits of the Philippines. As an export crop, its full potential is yet to be exploited. But the crop is notorious for its erratic flowering and highly seasonal bearing habits. The mango is best adapted to a warm tropical monsoon climate with a pronounced dry season (>3 months) followed by rains. However, information from other countries indicates that crops cultivated for a long time over an extended area show a high degree of diversity due to varied environmental influences.

The mango, because of its attractive appearance and the very pleasant taste of selected cultivars—is claimed to be the most important fruit of the tropics. It has been touted as 'apple of the tropics' but has also been described as a 'ball of tow soaked in turpentine and molasses' by critics. It is one of the most delicious fruits there is, although it has undesirable features including coarse fibrous strands through the flesh and the pungent and turpentine flavors of some cultivars.

Demand for mango in our developing country and other countries are very much increasing. However, production can be affected with changes in weather conditions or climate change. Climate change, triggered by global warming, is a creeping, very slow-start phenomenon, which is why it is hardly noticeable in our daily lives. It is when extreme events happen more often, when some species are slowly vanishing or when shorelines are little by little advancing, that suspicion of some changes in the global system is taking place. Climate change refers to any change in climate over time, whether due to natural variability or as a result of human activity.

Among the various climatic factors, temperature, rainfall and humidity have a greater bearing on mango production than irrigation and soils. Furthermore, the production of high quality mango fruit does not depend so much on elevation but on the range of temperatures available. The two important considerations for mango cultivation are a dry period at the time of flowering and sufficient heat during the time of fruit ripening. For optimum growth and productivity, 20–26°C is believed to be ideal. Temperatures exceeding 40°C may, especially in hot/dry areas, lead to sunburn of fruits and stunting of tree growth. Although not very impressive, mango trees of selected cultivars have been observed at elevations of up to about 1900 m. However, for more successful crops areas below 1200 m should be considered.

The amount of rainfall in a given locality is not as important as its intensity and distribution. Rainfall of 500–1000 mm at the right time of the year is sufficient for successful cultivation. However, the mango cannot do well in areas which experience frequent rains or very high humidity during the flowering period. Such conditions are not conducive to good fruit set and they increase the incidence of serious diseases like powdery mildew and anthracnose. Anthracnose can be a major problem as the same organism occurs on avocado, coffee and papaya caused by *Glomerella unguilata*. It can lowers mango production and it can be recognized by dark-brown circular to oval spots on the twigs and leaves of mango. Pink moist masses of spores of the fungus are produced on dead areas under moist conditions. Powdery mildew is quite common when low temperatures accompany high humidity.

Climate change is a major concern for mango production. Although this phenomenon is a global issue, its effect is felt locally. Climate irregularities are already

affecting global food production and it will probably have even more impact on years to come. Carbon dioxide or CO^2, a major greenhouse gas is a primary cause of global warming. Human activities provide a major source of carbon dioxide in our atmosphere by burning lots of fuels leading to the degradation of stratospheric ozone and increasing biologically harmful ultraviolet-B radiation. The main expected impacts of climate change will come as a result of climate variability due to changes in precipitation, increase in temperature and sea level rise. In terms of sector impacts, some of these include changes in agricultural yields for crops such as mango. Changes in land use, as a consequence, of changes in rainfall pattern which will push people to migrate to higher elevations where soil is less fertile causing the rate of conversion of forest to agricultural lands to increase increasing greenhouse emissions.

In contrast to predictions of mass disruptions to mango production and their resulting adverse social and environmental impacts, some components of global change may benefit plants. Carbon dioxide is a substrate for photosynthesis. As atmospheric carbon dioxide levels increase, photosynthesis rates and crop productivity may increase. Similarly, global warming may increase the duration of the cropping season in temperature and higher latitudes.

Importance of the Study

The result of the study could serve as a guide for farmers to program flower inducing activities to reduce losses due to climate change. Furthermore, the result can also be a guide for researches, institutions to identify technologies for specific situation of climatic change.

The results of the study would also serve as a guide for other researchers and students whom are interested to venture on the same research.

It would also help the mango growers to improve their production scheme to combat or cope up with the effect of global climate change.

Statement of the Problem

This study aimed to answer the following questions:

1. What are the weather changes for the past 20 years?
2. What are the levels of awareness of mango growers in the study area regarding climate change?
3. What are the demographic profiles of the study area?
4. What are the changes in production practices employed by the mango growers in Itogon?
5. What are the incidence of pest and diseases arises in the study area?
6. What are the constraints encountered by the mango growers and coping mechanism to combat climate change?

Objectives of the Study

The study aimed to document and investigate the effect of climate change on mango production at Dalupirip Itogon, Benguet.

Specifically, the study aimed to:

1. Document climatic changes for the last 20 years;
2. Determine the awareness, local knowledge and observations of farmers in the said locality regarding climate change;

3. Determine the effects of climate change on the following aspects:
    a. Changes in the demographic profile of the study area;
    b. Changes in the production practices of mango crop;
    c. Incidence of pest and diseases and other production problem;
4. Determine strategies or coping mechanisms employed by mango growers.

Scope and Delimitation

This study is concerned about the impact of climate change to the production of mango crop in Dalupirip Itogon, Benguet.

REVIEW OF LITERATURE

Mango

The mango crop is a deep-rooted, evergreen plant which can develop into huge trees, especially on deep soils. The height and shape varies considerably among seedlings and cultivars. Under optimum climatic conditions, the trees are erect and fast growing and the canopy can either be broad and rounded or more upright. Seedling trees can reach more than 20 m in height while grafted ones are usually half that size. The tree is long-lived with some specimens known to be over 150 years old and still producing fruit. The mature leaves are simple, entire, leathery, dark green and glossy; they are usually pale green or red while young. They are short-pointed, oblong and lanceolate in shape and relatively long and narrow, often measuring more than 30 cm in length and up to 13 cm in width (Salim *et.al*., 2002). New leaves are formed in periodic flushes about two to three times a year.

Mango is successfully grown on a wide range of soils. The trees do well in sandy soils at the coastline as well as on loam, and black cotton at other elevations. The essential prerequisites for good development of the trees are deep soils (at least 3 m), appropriate rainfall (500–1000 mm), good drainage, suitable altitude (0–1200 m) and preferably a pH value of between 5.5 and 7.5. The tree itself is not difficult to grow and, once well established, is relatively tolerant of drought, occasional flooding and poor soil condition. Irrigation in the first years after planting promotes flushing (and suppresses flowering), so that tree size increases quickly. Irrigation also widens the scope for intercropping, for example, with papaya, banana, pineapple or vegetables, during the establishment phase. When the trees are big enough to produce a substantial crop, irrigation is stopped, or at least interrupted long enough to impose quiescence leading to flower initiation.

Climate Change and Its Impact

Climate change is defined by Asian Development Bank (2009) as the variation in the Earth's global climate or regional climates over time scales ranging from decades to millions of years. Changes may be driven by internal processes, external factors or, most recently, by human activities. Pulse Asia describes climate change as "any long-term significant change in the average weather that a given region experience." It can be caused by dynamic processes on earth, variations in sunlight intensity, and in the past hundreds of years by human activities such as clearing of forests, technology and industry (ABS-CBN, 2010).

The United Nations Framework Convention on Climate Change (UNFCCC) put more emphasis on anthropogenic causes of climate change particularly fossil fuel burning (Tebtebba Foundation, 2009). The Third Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) as cited in FAO (2006) states that "there is new and stronger evidence that most of the warming observed over the last 50 years is attributable to human activities". Global average temperature increased about 0.6 C over the 20th century. However, Rincon and Virtucio (2008) in their report, Climate Change in the Philippines: A Contribution to the Country Environmental Analysis, debate that the average global temperature increase is higher at 0.74C. The increase results to decreasing extent of snow cover and ice while average sea levels and ocean heat content have both risen. This is supported by NASA findings which show that the five highest global annual average surface temperatures recorded in more than a century occurred only on the last 10 years (in 2005, 1998, 2003 and 2004 in descending order). Precipitation patterns characterizing land areas of the Northern Hemisphere have progressively changed. These

changes include more rainfall in the mid to high latitudes and, on the contrary, less rainfall in sub-tropics.

Warming would be particularly evident and rapid in land areas, with special reference those placed in high latitudes and during winter. Globally, precipitation is projected to rise, with the occurrence of more rainfall and larger annual variations in some regions and less in others. Average sea level would rise by 0.09-0.88 meters between 1999-2100. Unusual weather events would likely increase, including for instance greater frequency and intensity of El Niño type of weather patterns. According to these projections, many territories will experience intensified rainfalls; more violent cyclones will intervene in tropical areas while mid-latitude continental would be at risk of drought (FAO, 2006).

Poverty is the primary result of climate change. Climate irregularities affect our agriculture and food security, fresh water supply, and furthermore health constraints. As one farmer stated "*sugal id niman men garden*" (farming is a game of chance). This is evident in the fact that farmers are badly affected with climate change as observed in the increase of the new pest and diseases, crop destruction due to El Niño, La Niño, decreasing water volume and disruption of agricultural calendar. Quality of life is said to be deteriorating in statements such as "*rumigrigat ti biag*" (life is more difficult).

Climate Change in the Philippines and Its Impact

The Philippines, as a developing country and a biodiversity hotspot, is highly vulnerable to climate change impacts. As stated by Dr. Josefino Comiso, a senior scientist at the National Aeronautics and Space Administration (NASA), "The Philippines is not emitting a lot of carbon dioxide, but it's going to be a victim of climate change" (Burgonio, 2008).

The IPCC ranks Philippines as 4th in the Global Climate Risk Index. The index exposes the true cost of climate change which is not limited to economic losses but also human lives, cultural heritage and ecosystems (Jabines and Inventor, 2007). Furthermore, the country is said to be one of the most natural disaster-prone countries due to a combination of high incidence of typhoons, floods, landslides, droughts, volcanoes, earthquake, and the country's considerable vulnerability to these hazards (Rincon and Virtucio, 2008).

According to Dr. Leoncio Amadore, although it cannot be conclusively proven that a single event was or was not, affected by global warming, current scientific evidence strongly suggests that hurricanes and typhoons tend to become more destructive as ocean temperatures rise. Extreme weather events that our country has experienced recently "have one thing in common – persistent torrential rains, causing landslides and flash floods, killing people and destroying properties and the environment along its path."

The coastal ecosystems of the country are under major treat. As an archipelago which has the second largest coral reef cover in the world and a 36, 286 kilometers coastline which is roughly the equivalent of the Earth's circumference, the Philippines is at threat from large-scale impacts of climate change on the ocean. The coral reefs, in particular, are under immediate threat from massive bleaching due to warming of ocean temperature thereby endangering millions of inhabitants such as algae and hundreds of species of fish (Philippine Daily Inquirer, 2009). Of the 16 regions in the Philippines, only one is not vulnerable to sea level rise. However, this region, the mountainous Cordillera Administrative Region, is highly at risk from typhoons and variability in precipitation (Jabines and Inventor, 2007).

Climate change would also impinge on indigenous peoples and their customs and livelihood that are deeply rooted in the well-being of the environment, devaluing their "contribution to the conservation and protection of biological diversity and ecosystems which is crucial for the prevention of climate change, thereby, hindering their capabilities to mitigate climate change as well as to adapt to climate change as well. Tebtebba Foundation (2009) in its guide book on climate change states that though indigenous people have the least contribution to climate change as result of their harmonious interaction with their environment, they would be one of the most affected groups by climate change because they inhabit fragile environments.

Climate change's impact on the Philippines is most often associated with extreme weather disturbances such as typhoons and floods, which, in turn, affect many other sectors of economic life. Extreme weather conditions such as harsher storms, more frequent El Niño and La Niña and others are expected to intensify with climate change. The country, in particular being situated along the western rim of the Pacific Ring of Fire, a belt of active volcanoes and major earthquake faults, and the Pacific typhoon belt, disaster resulting from stronger and more frequent typhoons are very likely. As argued by Dr. Comiso, "if you have a warmer ocean, you get more evaporation. You also get stronger typhoons in the process". Furthermore Dr. Leoncio Amadore, a leading Filipino meteorologist, reported that the more frequent occurrence of severe El Niño and La Niña events, as well as deadly and damaging typhoons and other severe storms, floods in the Philippines is likely local manifestation of global climate trends (Jabines and Inventor, 2007).

Climate Change and Agriculture

Agriculture plays an important role in our economy. Without agriculture, man cannot survive. Agriculture sector provides food and vital raw materials for the rest of the economy. Moreover, agriculture is the dominant source of livelihood and employment, the importance of agriculture to the Philippine economy cannot be overemphasized. The sector most affected by climate change, so far, is agriculture and food security. With the significant variations in climate change and its element such as increasing temperature, changing rainfall pattern and increasing intensity, stronger and ill-timed typhoon, and others, many effects are perceived.

Farmers observed that the occurrence of pest and/or introduction of new pest and plant diseases have a seasonality and is affected by increase temperature. The warmer temperature causes faster evaporation, thus, more frequent watering of the vegetable crops is required. A warm weather makes crops and animals susceptible to diseases, the hotter the weather, the lower the resistance of the crops and animals to diseases. It has been widely acknowledged that colder climate have a limiting effect to the occurrence of pests and diseases; with climate getting warmer, increasing pests is expected. Crop destruction is also imminent. Since the country is visited annually by an average of 20 typhoons (PAG-ASA), it is also expected that crop loss due to this phenomenon is high. (ISRD-BSU, 2010).

Decrease in crop yield is an indicator of climate change. Erratic and extreme weather conditions can bring animals and human diseases. Lesser water supply for irrigation is also experienced during the summer brought by the El Niño phenomenon. The disruption of the agricultural calendar

The sharpest fall in agricultural productions are experienced during El Niño events and after the occurrence of severe tropical cyclones. Decreases in agricultural productivity and aquature will ensue due to the thermal and water-stress, sea-level rise, floods and droughts and tropical cyclones would diminish food security (Jabines and Inventor, 2007).

Planting time and growing season of mango have been changing due to erratic patterns of precipitation. Farmers, particularly those who depend on rainfall for water supply, have to take more risks in growing crops. When hit by El Niño in the middle of the growing season, the shortage of water will impair crop growth and consequently reduce its potential yield. During the El Niño period, mango becomes vulnerable to pest attacks and diseases. La Niña years bring heavy rains, causing runoff, severe erosion of fertile soils, and inundation of agricultural areas (ADB, 2009).

Some mango growers whom are knowledgeable adapt the challenging climate through adjustment of planting/harvesting dates or changes in fertilization rates, and irrigation application. Farmers with limited financial resources and farming systems with few adaptive technological priorities available to limit or reverse adverse climate change may suffer significant disruption and financial loss for relatively small changes in crop yields and productivity of these farms may be located in areas more likely to suffer yield losses (Reilly, 1992).

Definition of terms

Climate, a composite generalization of day-to-day weather condition over a long period of time

Weather, is the momentary state of the atmosphere. Primarily, weather is a combination of four elements: (1) temperature, (2) precipitation/humidity, (3) wind and (4) air pressure.

METHODOLOGY

Locale and Time of the Study

The study was conducted in Dalupirip Itogon, Benguet where mango growers had constraints regarding the crop. The study was conducted on December, 2011.

Respondents of the Study

The respondents of the study were the mango crop farmers producing mangoes in Dalupirip Itogon, Benguet. Total enumeration was employed in the selection of the respondents and where there were 40 mango producers. These farmers served as the source of information/data.

Data Gathering Procedure

The study used primary and secondary data. Primary data was gathered through survey and interview. Personal interview was employed with the aid of interview guide and field observation or transect walk to validate data gathered from interview. Secondary data on weather was gathered from PAG-ASA- Baguio City. Other data such as agro-demographic profile was gathered from Barangay Officials.

Data Gathered

The data gathered are the physical features, yield of production, and level of knowledge and observations of farmers related to climate change.

Data Analysis

The data collected was consolidated, tabulated and analyzed using frequency/descriptive analysis and other appropriate statistical tool.

RESULTS AND DISCUSSION

Profile of the Respondents

The socio-demographic profile of the respondents include their age, gender, civil status, educational attainment/background, number of year/s engaged in mango production, major source of income, and other sources of livelihood. These are presented in Table 1.

Age. One fourth of the respondents belonged to the age bracket of 41-50 years old. The mean age of the respondents was 46.8 years. The youngest respondent was 19 years old while the oldest was 74 years old.

Gender. Majority of the survey respondents were males.

Civil status. There were 60% of the respondents who were married, and only 27.5% were single.

Educational attainment. Some (37.5%) of the respondents have graduated high school and 12.5% were elementary graduates. Only 20% of the respondents hold a degree in college. This emphasized that most of the farmers in the locality have attended formal education.

Years engaged in mango production. The table further revealed that 25% of the respondents have been producing mango for almost 26 years and above. 12.5% of the respondents have been engaged in mango production for 21-25 years, 12.5% for 5-10 years, and less than 5 years.

Sources of income. The major source of income of the respondents was farming. Other sources of income include mining (22.5%), business (10%), and teaching, carpentry works, and private employee (2.5%).

Table 1. Profile of the respondents

PARTICULAR	FREQUENCY	PERCENTAGE
Age (years)		`
14-20	1	2.50
21-30	8	20.00
31-40	5	12.50
41-50	10	25.00
51-60	7	17.50
61-70	5	12.50
71-80	4	10.00
TOTAL	40	100.00
Mean age - 46.8		
Gender		
Male	26	65.00
Female	14	35.00
TOTAL	40	100.00
Civil status		
Married	24	60.00
Single	11	27.50
Widow/widower	3	7.50
Separated	2	5.00
TOTAL	40	100.00

Table 1. Continued…

PARTICULAR	FREQUENCY	PERCENTAGE
Educational attainment		
Elementary level	1	2.50
Elementary graduate	5	12.50
High school level	2	5.00
High school graduate	15	37.50
Vocational graduate	1	2.50
College level	5	12.50
College graduate	8	20.00
Undergraduate	3	7.50
TOTAL	40	100.00
Number of year/s engaged in mango production (year)		
Less than 5	5	12.50
5-10	5	12.50
11-15	7	17.50
16-20	8	20.00
21-25	5	12.50
26 and above	10	25.00
TOTAL	40	100.00

Table 1. Continued…

PARTICULAR	FREQUENCY	PERCENTAGE
Sources of income		
Farming	40	100.00
Business related	4	10.00
Mining	9	22.50
Government employee	1	2.50
Teaching	1	2.50
Carpentry	1	2.50
Private employee	1	2.50

Weather Data

Table 2 shows the weather data from year 1990 to year 2010. High relative humidity was experienced in the year 2001 which was 86.67 average mean. In the year 1997, data shows that there was a rise in temperature which was 28.77^0C while the minimum temperature was experienced in the year 1999 which was 12.32^0C. In year 1990, it was experienced that there is a high rainfall at 15.07 mms while the lowest was in the year 2006 at 2.06 mms. The weather data shows that from 1990 to 2010 there is a gradual increase and decrease yearly in temperature.

Table 2. Average weather data from 1990-2010 observed in Baguio-PAGASA

YEAR	RELATIVE HUMIDITY (%)	MAXIMUM TEMPERATURE (^{0}C)	MINIMUM TEMPERATURE (^{0}C)	RAINFALL AMOUNT (mms)
1990	80.92	23.50	14.95	15.07
1991	----	----	----	----
1992	81.83	23.36	13.66	13.92
1993	85.17	23.53	13.99	9.90
1994	84.92	23.42	13.77	9.39
1995	84.50	23.71	14.24	10.93
1996	84.17	23.92	14.38	8.66
1997	83.83	28.77	13.99	6.56
1998	85.33	24.80	13.12	14.64
1999	85.75	23.63	12.32	14.73
2000	85.83	23.88	17.98	6.53
2001	86.67	24.14	15.81	12.19
2002	83.25	23.81	15.03	11.42
2003	----	23.50	14.70	9.92
2004	----	24.04	14.81	14.68
2005	80.17	24.55	19.99	2.75
2006	79.00	25.16	19.31	2.44
2007	82.09	24.61	19.35	6.31
2008	84.19	24.80	19.00	2.06
2009	86.00	24.74	18.99	5.00
2010	86.17	24.54	16.32	9.60

Agro- Ecological Profile of the Respondents

Total farm area. In the study, the interviewee used the Department of Agriculture's1995 classification of farm size in the Cordillera Administrative Region which was benchmarked as follows: a) small scale (less than 0.25 hectare or 2500 m2); b) medium-scale (more than 0.25 hectare but less than 1 hectare or >2500 m2, <10,000 m2); c) large-scale (more than 1 hectare or >10,000m2. Overall, 35% of the mango farmer's land areas fall under small-scale farms and medium scale farms. Only 30% were recorded to be cultivating large-scale farms.

Farm land tenure. The table revealed that most (90%) of the respondents owned the land they utilized for mango production. Only 7.5% of the respondents rented the land for mango production. There was one (2.5%) of the respondent who takes good care of the land and at the same time manages the land and care for the mango trees.

Fruits other than mango/vegetables produce. Majority of the respondents have papaya, jackfruit plant in their farm. Other crops are grown in the farm in order to maximize the land. It was identified that only 12 farmers (34.29%) respondents plant rice. Table 3 revealed that the respondents were producing vulnerable crops which are pears, lanzones, and rambutan.

Mango trees in the farm. Majority of the respondents have 81 to 120 mango trees in their farm area. Only 2.5% among the 40 respondents have 201 and above mango trees.

Table 3. Agro- ecological profile of the respondents

PARTICULARS	FREQUENCY	PERCENTAGE
Farm size		
Small-scale farms	14	35.00
Medium-scale farms	14	35.00
Large-scale farms	12	30.00
TOTAL	40	100.00
Farm land tenure		
Own land	36	90.00
Rented land	3	7.50
Caretaker	1	2.50
TOTAL	40	100.00
Fruits other than mango/ vegetables in the farm		
Papaya	35	87.50
Banana	21	52.50
Avocado	26	65.00
Jackfruit	29	72.50
Rice	12	30.00
Coconut	22	55.00
Soursop	13	32.50
Star-apple	3	7.50
Pomelo	4	10.00

Table 3. Continued…

PARTICULAR	FREQUENCY	PERCENTAGE
Citrus	1	2.50
Custard apple	2	5.00
Pears	1	2.50
Lanzones	2	5.00
Rambutan	3	7.50
Chico	3	7.50
Coffee	1	2.50
Casava	1	2.50
Eggplant	5	12.50
Mango trees in farm		
1-40	7	17.50
41-80	9	22.50
81-120	16	40.00
121-160	4	10.00
161-200	3	7.50
201 & above	1	2.50
TOTAL	40	100.00

Perceptions on Climate Change

Awareness on climate change. Majority of the respondents were knowledgeable on what climatic change is. A few (5%), however, claimed that they were not aware of climate change. This implies that all the respondents were aware on climatic irregularities that are happening nowadays.

Changes in the climate. In the study site 75% of the surveyed respondents noted a significant increase in temperature. Comments like, "subra ampetang tadta sunga dagijay han nga agbunga ah prutas ditoy ket nagsibunga dan" (nowadays, the heat is unbearable, that is the reason why fruit bearing trees that are not bearing fruits in the pasts years are bearing fruits now). Most (71.05%) of the respondents observed extremes in temperature within a daily scale. During morning, the temperature is observably cold and during night time the air is cool as stated by a respondent, ("teg-in nu agsapa, rabie met ket mayat angin na"). However, at midday the heat of the sun is extremely hot. Some (39.27%) of the respondents observed that there was abrupt changes or rise in temperature, 47.39% of the respondents observed that there was an irregularity in rain pattern and 31.58% respondents claimed that there is stronger rainfall intensity. Rainfall intensity refers to the volume of precipitation per unit time.

This general observation of respondents is supported by related literature. Climatological data from 1951 to 2005 by Rosalina de Guzman, a Philippine Atmospheric, Geophysical and Astronomical Administration (PAGASA) weather expert, showed that Benguet and Baguio City are experiencing more warm days, or periods of maximum temperatures, and fewer cold days, or periods of minimum temperature. It is projected that the province would experience an average or mean temperature increase of 0.8^0C to 1^0C

by 2020 and from 1.7^{0}C to 2.1^{0}C by 2050. Benguet PAGASA verified that the increase in temperature and rainfall are two manifestations of climate change (Upnorth Tribune, 2010). An increase of even 1^{0}C would be considered as critical. As stated by Dr. Josefino Comiso, a senior scientist at the National Aeronautics and Space Administration (NASA) and a contributing author to the report on climate change of Nobel winner Inter-Governmental Panel on Climate Change, if you change the temperature by even a fraction of a degree to 1 degree, a lot of species could disappear.

The rainfall pattern is also observed to be irregular by 55.26% of the respondents as reflected in their statement "ijy mysa barangay nga nalabasan mi ket agtudtudo ditoy ketdi ket awan pulos pati arbis awan met lang" (in the other barangay, it is raining while in our area there's no rain neither drizzle). Majority (55.26%) of the respondents observed that there is occurrences of super typhoon in this locality and 18.42% of the respondents observed that there is change in wind direction while 39.47% observed that the wind is stronger as jokingly stated by the respondent as "nu agangin kala maitayab ti nuang ko ngem awan met gayam nuang ko" (when the wind blew as if it will blow my carabao but, I have no carabao at all) and "kala nga ada ti ipu-ipo en, kala maitayab py en ti kay-kayo" (as if there is tornado, standing trees were likely to be uprooted). Some (21.05%) of the respondents observed that there was abrupt changes in weather conditions while 28.95% observed that there is changes in seasons like prolong dry or wet season. This was verified by the respondent as stated "tatdta nga panawen, atidog ti tiempo en ti panagtutudo kasta met ti tiempo ti kapudotan" (there is a long wet and dry season nowadays). Almost half of the respondents (42.11%) observed the El Niño and La Niña phenomena while 15.79% knew that one of the effects of climate change is longer drought.

View on climate change. The table 4 shows that there were 39.47% of the respondents who have positive and negative view regarding climate change. Another 42.11% of the respondents claimed that they have a positive view regarding climate change and 23.68% have negative view regarding this phenomenon. This implies that respondents have neither good nor bad interaction regarding climate change. Positive view, it is because fruits just like lanzones and/or rambutan which were found in the lowlands can bear fruit nowadays. Negative, because of climatic irregularities experienced an occurrence of new pest and diseases were observed just like the scab, and others. As stated by one of the respondents, "idi awan dayta peste tadta ada" (in the recent years the pest was not observed but nowadays they were arising). It is either positive or negative, because climate changes have good and bad effects in the locality.

Main sources of information. Radio (86.84%) and television (73.68%) were the accessible source of information in the locality, which is three-fourths of the respondents. Mango growers, especially rely on local radio stations for information regarding new technology for farming. For most (73.68%), had a personal observations on changes in climate which contributed to their level of awareness regarding this phenomenon. It is also interesting to note that very few of the respondents received information from local government unit which is 10.53% and government agencies which is 18.42%.

Table 4. Perceptions on climate change

PARTICULARS	FREQUENCY	PERCENTAGE
Awareness to Climate Change		
Aware	35	95.00
Unaware	5	5.00
TOTAL	40	100.00
Changes in the climate		
Increase of temperature	30	78.94
Extreme hot (noon)- extreme cold (am/pm)	27	71.05
Abrupt changes in temperature	15	39.47
Stronger rain fall intensity	12	31.58
Irregular rain pattern	21	55.26
Occurrence of super typhoons	21	55.26
Change in wind direction	7	18.42
Stronger wind	15	39.47
Abrupt changes in weather conditions	8	21.05
Changes in seasons like prolong dry/wet season	11	21.05
La Niña	16	42.11
El Niño	16	42.11
Longer drought	6	15.79
Perception or view on climate change		
Positive	16	42.11
Negative	9	23.68

Table 4. Continued…

PARTICULAR	FREQUENCY	PERCENTAGE
Both positive and negative	15	39.47
TOTAL	40	100.00
Main sources of information		
TV	28	73.68
Newspaper	20	52.63
School	3	7.89
Family/friends	7	18.42
Personal experience/observations	28	73.68
Radio	33	86.84
Internet	7	18.42
Government Agency	7	18.42
Local Government Agency(LGU)	4	10.53

Production Practices

Type of area for production. Table 5 shows that 82.5% of the respondents utilized a sloping area for production. Seven (17.5%) of the respondents have a flat terrain for mango production.

Cropping system practices. Majority (65.5%) of the mango producers do practice intercrop crops such as leguminous crops, rice, and especially fruit bearing trees. Only 32.5% of the respondents do not suggest intercrop crops. According to the respondents, intercropping was helpful in maintaining the nutrient of the soil and for the control of pests and diseases.

Changes in farm landscape/topography. Among the 40 respondents 62.6% of them had a change in farm topography from year 1990 to present. Only 37.5% of the respondents did not suffer from these changes. The table shows that most (84%) among the 25 respondents that have a change in their farm landscape have incurred a change in soil structure, 80% has a change in soil fertility, and 8% claimed that there area for production which is sloping became flat.

Causes of changes in farm topography. Table 5 shows that most (80%) of the 25 respondents who claimed that there is a change in farm landscape mentioned that the cause is the changing weather. Only 16% of the respondents claimed that supply of water became scarce because of changing weather and landslides in the neighboring farm. 36% claimed that the change of farm landscape is because of landslides in the farm and 24% is because of human intervention. Another cause also of change in farm landscape is due to El Niño (36%) and La Niña (28%).

Changes in practices from year 1990 to present. Three-fourths of the mango growers incurred a change in practices from year 1990 to present and only 25% do not have changes in practices. Spraying with potassium has increased from 53.33% of the year 1990 to 2000 into 76.67% of the remaining years to present. Spraying with insecticide has also increased from 36.67% to 83.33% while spray of fungicide also increased from 30% to 40%. Spray of herbicide has also increased from 3.33% to 10%. Among the 40 mango growers only 33.33% of them do not spray chemicals from 1990 to 2000 while these present years mostly of the respondents spray chemicals. Smudging or smoking during the years 1990 to present was also practiced. Fertilizer application is practiced by some (16.67%) during the years 1990 to 2000 while most (80%) of the respondents do fertilize

the mango crop from 2001 to present. This indicates that fertilizer application is common in the locality, and spraying of chemicals to control pest and diseases had also increased.

Table 5. Production practices

PARTICULARS	FREQUENCY	PERCENTAGE
Type of area for production		
Sloping area	33	82.50
Flat terrain	7	17.50
TOTAL	40	100.00
Cropping system practices		
Intercropping	27	67.50
Mono-cropping	13	32.50
TOTAL	40	100.00
Causes of changes in farm landscape/topography		
Weather conditions	20	80
Supply of water became scarce	4	16
Landslides in the farm	9	36
Landslides of neighboring farm	4	16
Human intervention	6	24
El Niño	9	36

Table 5. Continued…

PARTICULAR	FREQUENCY	PERCENTAGE
La Niña	7	28
Changes in practices from 1990 to present		

There are changes	30	75.00
No change	10	67.50
Change from 1990 to 2000		
Spraying with potassium	16	53.33
Spraying with insecticide	11	36.67
Spraying with fungicide	9	30.00
Spraying with herbicide	1	3.33
No spraying	10	33.33
Smudging/smoking	13	43.33
Fertilization	5	16.67
Change from 2001 to present		
Spraying with potassium	23	76.67
Spraying with insecticide	25	83.33
Spraying with fungicide	12	40.00
Spraying with herbicide	3	10.00
Smudging/smoking	3	10.00
Fertilization	32	80.00

Changes in Yield per Mango Tree

Table 6 revealed that three-fourths of the respondents incurred a change in the average yield per mango tree per season. Twenty-five percent (25%) of the mango growers did not observed change in the average yield per mango tree. A productive tree will yield approximately 500 kilos but once pests and diseases will occur, production will decreased by 30%. Result implies that yield produced was low.

Problems Encountered in Production

Problems in production. Table 7 presents the problems encountered by the farmers in mango production during the years 1990 to present. Most (90%) of the respondents encountered a problem regarding the crop while 10% did not encounter any problem. The major problem encountered in mango production was environmental factors such as pests, diseases, storms and typhoon. The data shows that there is an increase in plant pest and diseases from 52.78% (1990-2000) to 83.33% (2001-2010). Crops destroyed by typhoons also increased from 19.44% into 94.44%. The data noted that there is a significant increase of problem encountered which is weather related as 16.67%, year 1990-2000 into 69.44%, year 2001 to present. These problems causes damaged in the mango production producing non-marketable yield.

Table 6. Changes in yield

PARTICULAR	FREQUENCY	PERCENTAGE
Observed change in yield	30	75.00
Not observed change in yield	10	25.00
TOTAL	40	100.00

Lack of finance or capital for production is another problem encountered by the respondents. Although, the farmers financed their farming, the total input required by the mango crop was not sustained. Thus, the nutrient requirement of crop was not sustained.

Table 7. Problems encountered

PROBLEM	FREQUENCY	PERCENTAGE
Encountered problem	36	90.00
No problem	4	10.00
TOTAL	40	100.00
Problems encountered from year 1990 to 2000		
Prevalence of plant pest and diseases	19	52.78
Crop destroyed by typhoons	7	19.44
Weather related	6	16.67
High price of farm inputs	19	52.78
Low cost of harvested crop	18	50.00
No capital/money	23	63.89
Problems encountered from year 2001-2010		
Prevalence of plant pest and diseases	30	83.33
Crop destroyed by typhoons	34	94.44
Weather related	25	69.33
High price of farm inputs	28	77.78
Low cost of harvested crop	22	61.11
No capital/money	26	72.22

Lack of education or training on the production method/technology was also one of the problems mentioned by the respondents. As shown in the profile, most of the respondents have not reached college and have not attended any training or seminars on mango production.

Changes in Production/Cultural Management Production

Practice organic agriculture. Farmers in the locality do not observe purely organic agriculture. Most (80%) of the respondents uses chemicals for their crops. A small percentage (20%) is engaged in organic farming. This indicates that agrochemicals and inorganic fertilizers are used extensively in the locality.

Application of fertilizers. Results in the table shows that all of the respondents' uses nitrogen, phosphorous and potassium fertilizers while only, 21.87% of the 32 respondent's uses organic fertilizer which is compost. These fertilizers promotes roots and flower development, and for fruiting and ripening.

Pest control practices. Table 6 previously, revealed that almost all the respondents practiced intercropping. Insect-repellant crops were intercropped with mango to deter pests from devouring the mango crop and intercrop companion crops to control the population of pest. A result of the survey shows about three-fourths of the mango producers' uses insecticides/pesticides. Only few (30.56%) do practice manual removal of pest or infected parts of mango. Accordingly, the pest and plant diseases are abundant thus; manual removal of pests is impractical. Fungicide as pest control is practiced by 75% of the respondents as fungicides were used to combat fungi-induced diseases.

Table 8. Changes in production/cultural management practices

PARTICULARS	FREQUENCY	PERCENTAGE
Practice organic agriculture		
Practice organic farming	8	20.00
Do not practice	32	80.00
TOTAL	40	100.00
Apply fertilizers		
Applying	32	80.00
Not applying	8	20.00
Fertilizers applied		
Complete	32	100.00
Compost	7	21.87
Uses pesticide/pest management		
Uses pesticide	36	90.00
Do not use pesticide	4	10.00
TOTAL	40	100.00
Pesticide applied/pest management		
Insecticide	31	86.11
Manual removal of pest/infected parts	9	30.56
Fungicide	24	75.00

Observation on the Incidence of Pests

Table 9 revealed that there is an increase of pest from year 2001 to 2010. Mango fruit fly were low during wet season and moderate during dry season since year 1990 to 2000 while in the year 2001 to 2010 data shows that there was an increase in the said pest. In 1990 to 2000, incidence of mango seed weevils was moderate during dry season and in 2001 to 2010, the pests were low during wet and dry season. Incidence of mango hoppers was observed to be moderate during wet and dry season since the year 1990 to 2000 and very high during wet and dry season in the year 2001 to 2010. In the year 1990 to 2000, mango tip borers were low during wet season and in the year 2001 to 2010, the pest were low during wet season while very high during dry season. Twig cutters were observed high during dry season of 2001 to 2010 and low during wet season. In the year 1990 to 2000, mealy bugs were low during wet season and high during dry season. Mealy bugs were observed to be low during wet season and high during dry season in the year 2001 to 2010. Mango cecid fly was only observed low during dry season in the year 2001 to 2010. Result implies that arising new pests were observed in the locality and occurs during wet and dry season that damages crops in field were still being experienced now.

Table 9. Incidence of pests

PEST	1990-2000				2001-2010			
	MEAN				MEAN			
	WET	SCALE	DRY	SCALE	WET	SCALE	DRY	SCALE
Mango fruit fly	2.625	Low	3.425	Moderate	2.45	Low	3.9	High
Seed weevil	1.725	None	2.875	Moderate	2.575	Low	2.3	Low
Mango hopper	2.15	Moderate	3.225	Moderate	4.65	Very high	4.5	Very high
Mango tip borers	1.8	None	2.575	Low	2.3	Low	4.375	Very high
Twig cutters	1.625	None	2.375	Low	2.375	Low	3.5	High
Mealy bugs	2.275	Low	3	Moderate	2.55	Low	3.6	High
Mango cecid fly	1.35	None	1.65	None	1.85	None	2.6	Low

Legend: 1-1.8 none 2.7-3.4 moderate 4.3-5 very high
1.9-2.6 low 3.5-4.2 high

Observation on the Incidence of Diseases

Table 10 revealed that prevalence of diseases increased from year 2000 to 2010. In 1990 to 2000, anthracnose was moderate during wet and dry season while in the year 2001 to 2010, the disease was high during wet and dry season. Powdery mildew was low during wet season and during moderate dry season in the year 1990 to 2000. In 2001 to 2010, powdery mildew was moderate during wet and dry season. Scabs were observed in the year 2001 to 2010 during wet and dry season. Diplodia stem-end rot were observed low during dry season in the years 1990 to 2010. Sooty mold was observed only during dry season in the year 2001 to 2010. The result implies that a new disease was observed in the locality.

Table 10. Incidence of diseases

DISEASES	1990-2000				2001-2010			
	MEAN				MEAN			
	WET	SCALE	DRY	SCALE	WET	SCALE	DRY	SCALE
Anthracnose	3.1	Moderate	3.175	Moderate	3.725	High	3.7	High
Powdery Mildew	2.45	Low	2.4	Moderate	3.125	Moderate	3.2	Moderate
Scab	1.6	None	1.5	None	2.6	Low	2.425	Low
Diplodia stem-end rot	1.7	None	2.075	Low	1.8	None	2.4	Low
Sooty mold	1.425	None	1.4	None	1.75	None	2.125	Low

Legend: 1-1.8 none 2.7-3.4 moderate 4.3-5 very high
1.9-2.6 low 3.5-4.2 high

Adaptation Measures

Pests and diseases are common to crops and are widely distributed and considered to be a serious problem to farmers. Spray of chemicals is dominantly used by most 80% of the respondents and only 20% do practice biological control. Farmers indicated that the use of agro-chemicals increased their yields and improve the appearance of the produce. Manual picking of the pests and diseases is practiced only by 32.5% farmers and uses of organic control were used only by 20% of the respondents. Another 27.5% of the respondents select cultivars in order to have a better yield. Some (42.5%) of the

respondents controls fertilizer application, 62.5% of the farmers suggests timely spraying, and only 25% practice orchard or field sanitation. Selection of proper orchard site is commonly done by some (17.5%). Another prevention and control of pests by farmers is scheduled flower induction after rainy season or during the dry months.

Table 11. Coping mechanisms

PARTICULAR	FREQUENCY	PERCENTAGE
Spray of chemicals	32	80.00
Biological control	8	20.00
Manual picking of pests and or infected parts	13	32.50
Use of organic control	8	20.00
Selection of cultivars	11	27.50
Controlled fertilizer application	17	42.50
Timely spraying	25	62.50
Orchard sanitation	10	25.00
Selection of proper orchard site	7	17.50
Bagging/wrapping of the fruits	8	20.00
Pruning, after harvest	28	70.00
Grafting	3	7.50
Change of mango elevation	1	2.50
Uses stick/stunt in order for the tree not easily blown by the wind	8	20.00
Cutting the top of mango tree	1	2.50

Wrapping of fruits were only practice by some of the farmers (20%) in order to protect mangoes from pests and diseases. Pruning, after harvest is mostly done by 70% of the respondents. This is to allow the sunlight to penetrate in the crown and free air circulation, thereby reducing pests and diseases. In general, pruned trees produce bigger and high quality fruits compared to not pruned trees. 7.5% of the respondents practice grafting trees. Only 2.5% of the respondent changes the mango elevation, 20% uses stunt or stick in order for the tree not to be easily blown by the wind, and one (2.5%) do cut the top of mango tree.

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Summary

This study was conducted in barangay Dalupirip Itogon, Benguet. This study aimed to determine the weather changes for the past 20 years and to find out the levels of awareness of mango growers regarding climate change and production practices. Also, the study aimed to determine the incidences of pest and diseases occurred in the area and to determine the constraints encountered by the mango producers and lastly, the coping mechanisms or adaptation mechanisms employed by the farmers. The study was conducted on December, 2011. Data gathering was done with the aid of interview questionnaire and field observation method.

Majority of the respondents were in their middle age, male, married, engaged in farming almost of their lives and major source of income is farming. With regards to their educational attainment, all of them have attended formal education but still, knowledge on proper mango production practices is limited. Majority of the respondents practice conventional farming.

Majority of the respondents were knowledgeable and have a positive view/perception regarding climate change. Radio and TV are the accessible source of information in the locality. Majority of the respondents have personal observations of changes in climate and had contributed to their awareness of this phenomenon.

Regarding production practices, majority of the respondents utilized a sloping farm landscape. When it comes to pests control practices, majority of the respondents used insect-repellant crops to intercrop with mango to maintain nutrient of the soil and to deter

pests from devouring their target crops and intercrop companion crops to control the population of the pest.

Change on farm landscape/topography was determined which were changes in soil structure, changes in soil fertility and lastly, sloping production area became flat. Changing weather condition is the major changes. Spraying of chemicals increased nowadays, smudging or smoking which is a cultural/traditional practice became inefficient but still practiced by some mango growers.

Major problems the respondents encountered were environmental factors such as, pests and diseases, typhoons, and storms. These were the reasons why most of the respondents did not market their produce that caused loss of income to the families. Another major problem which farmers are facing now is the lack of financial needs. The respondents cannot buy all the materials needed in mango production that is the reason why some respondents do not manage well the crop.

Conclusions

Based on the findings, the following conclusions were made.

1. All the farmers in Dalupirip Itogon, Benguet depend on farming for their income/livelihood. Second to farming is mining.

2. Climate change has an effect on mango production in the past 20 years in terms of weather and climatologically data. Climate change has a positive and negative effect to mango and other fruit farmers. Warming induces fruit trees to bear fruits.

3. Climate changes are dominantly experienced by the respondents although not aware of the word, but describe it by themselves or on their own understanding regarding the phenomena.

4. Mango producers adapt the climatic change that arises in the area through their practices in the field such as timely spraying, orchard sanitation, controlled fertilizer application, and pruning after harvest

5. Farmers resort to chemical control of pest and diseases which was prevalent in this season and in the area.

Recommendations

In line with the findings of the study, the following recommendations were derived. Arising of new and increased pests and diseases are common these days, concerned agencies just like Department of Agriculture (DA) or Benguet State University (BSU) has the technologies and or researches regarding this matter. In this regard, DA, BSU or any concerned agencies should train and/or teach farmers the strategies and or integrated pest management on how to cope up with these arising pests and diseases, and most especially, the phenomena observed.

Moreover, farmers should minimize the usage and/or application of inorganic fertilizers, and other chemicals because these chemical pollutes air, water and soil contributing to climate change. Furthermore, it is recommended that, farmers to go back to traditional production practices or organic production.

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