MITIGATING CLIMATE RISKS UTILIZING GOOD PRACTICES OPTIONS IN UPLAND ECOSYSTEMS OF BICOL REGION, PHILIPPINES

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 ISSN: 1923-6654 (print)
ISSN 1923-6662 (online). Available at http://www.ssrn.com/link/OIDA-Intl-Journal-Sustainable-Dev.html

Abstract: Climate change is widely considered as one of the major threats to national development and stability. Managing climate risks in upland agriculture is one of the major challenges of today as it poses a serious peril to food security and the reduction of poverty. Bicol Region, Philippines, most particularly is witnessing a clear increase in extreme weather conditions mainly heavy rains, floods, typhoons and soil erosion or landslides - afflicting even a larger number of people across provinces and causing growing amounts of human and economic losses. Extreme climate events regularly affect the various sectors including the upland and rainfed agro-ecological zones. At present, there are no pronounced wet or dry season in the region as the climatic variability is very persistent. Impacts of extreme events caused by calamities frequently accumulate into hindering the development gains. Specifically, the frequent occurrence of rain due to La Niña during the cropping cycles for upland agro-ecological zones happens to be the dominant reason for crop investment failure and poor production. Likewise, effects of climate risks on these hazard prone areas are likely to increase the exposure of people, mainly the poor to loss of perceived revenues. Unless their vulnerabilities due to climate-related losses are addressed and reduced, the development of these marginal households can never be achieved. The paper highlights the good practices options adopted by farmers through the intensification of crop diversification strategies in addressing climate risks. Coupled with the application of soil analysis, organic farming techniques have showed promising results compared to the farming practices which were traditionally observed by farmers. The disaster risk management practices and approaches were recommended to upland vegetable farming communities to ensure production even at the onset of calamities.

Keywords: Climate Ecosystems Mitigating Risks Upland

INTRODUCTION

Filipino farmers face various types of risks in the process of agricultural production. The nature and magnitude of risk which agricultural producers face varies from farmer to farmer and from province to province. What is certain; however, is that the existence of potential risks in farming increases the vulnerability of agricultural production, especially small and marginal farmers and those operating in less favourable production environments. Vulnerability of the agricultural producers, taking for example, the farmers situated in the upland agro-ecological zones is compounded by their low carrying capacity. Another is the increased dependence on loans from institutional and private sources for meeting consumption requirements and for coping with the consequent output and income losses. Vulnerability of these producers arises on account of financial loss due to price variability in agricultural commodities. However, and most often, major risk of loss of production is due to unfavourable weather and soil conditions. Given the large proportion of area under such a risky production environment, the number of upland farmers who are subjected to production risks is obviously high. Yield and production risks on account of rainfall variability are compounded by poor soil environment in which producers cultivate their crops (Mathur and Singh, 2005). Likewise, problems of flooding, waterlogging and mudslides are increasing and considerable losses to individual farmers occur on account of climate hazards due to typhoons and heavy rains.

The upland agricultural ecosystems can be found all over the Bicol Region. Generally they are by their nature sensitive areas with a high ecological value. Due to their physical conditions, environmental value and recurring nature, they are basically unsuitable for agricultural production. However, due to and in many cases strategic location and/or suitability for agricultural production there is often a tremendous pressure to develop these areas for various types of land use specifically for upland production. Due to the lack of other areas which could be devoted for vegetable farming and production of other crops for additional income, these spaces are being utilized. Due to this, such areas become increasingly vulnerable for extreme weather conditions that will have their impact in terms of crop management during the onset of heavy rains and typhoons (Schultz, 2010).

The main relevant issue focusing on mitigating risks in disaster-prone agricultural areas in the mainland of the Bicol Region is presented in this paper. Attention is paid to identify the climate hazards affecting upland vegetable farming villages and to determine the coping mechanisms of the farmers against recurring natural disasters. The study would also determine the production and existing cultural practices of upland vegetable farmers in the climate risk-prone villages. Although the changes due to these processes may be of different speed and magnitude, they all result in an increase in vulnerability and requirement of the amount of measures to be taken with respect to the capability of farmers in improving upland vegetable farming production despite climate risks.

MATERIALS AND METHODS

The project sites were selected as they form part of the project area of the Food and Agriculture Organization (FAO) assisted undertaking entitled: "Strengthening Capacities for Climate Risk Management and Disaster Preparedness in Selected Provinces of the Bicol Region, Philippines". The project assistance is deemed to improve the early warning system, build the capacity of local government to implement community-based disaster risk management plan and introduce improved cropping systems, practices and water management measures for climate risk mitigation. The sites identified are the municipalities of Buhi, Guinobatan, and Gubat in Camarines Sur, Albay and Sorsogon Provinces, respectively. The areas were identified from a series of consultations and workshops which came up with an agreed set of selection criteria for the barangays in the said municipalities: (a) areas with high level of dependence on the agriculture sector; (b) existence of well-established functioning farmers' organization; (c) selected sites should have varying agro-ecological conditions, rainfed (upland), irrigated (lowland), existing fishponds (riverine); (d) farmers are willing to use their fields for demonstration purposes and participate to the training programs; (e) residents and livelihood groups were displaced after the recent typhoon but remain vulnerable for future risks; (f) sites are accessible to various means of transport and if possible with access to electric source of power; (g) presence of Barangay Disaster Coordinating Council; and (h) receptiveness of the Barangay Council (FAO TCP/PHI/3203, 2009; Project Brief, 2009).

Taking the above-mentioned criteria as basis, the following three priority barangays per municipality were selected: San Ramon, Igbac, and San Buenaventura for Buhi, Camarines Sur; Minto, Masarawag, and Mauraro for Guinobatan, Albay; and Ariman, Rizal, and Bagacay for the municipality of Gubat, Sorsogon. Site visits, preliminary information and data gathering were conducted in the local government units (LGUs) of each municipality and individual barangays concerned to obtain the profiles, socio-cultural setting, hazard vulnerability context, predominant crops and good practices options being undertaken by the farming households. After determining these major insights, the farmers from the upland agricultural areas have implemented the identified options potential for adaptation.

The study used both qualitative and quantitative methods in data collection. Focused group discussions with farmers and interviews with key informants in the targeted areas were conducted. An analysis of the nature and magnitude of risk which the upland farmers face on account of the above mentioned conditions is essential to develop coping strategies to manage eventualities arising on account of the risks. The kind of strategy that farmers adopt in order to cope with crop failures and reduced yields and the impact of the manifestation of risk on the income security of the producers, is often based on the farmers' previous experience of such an eventuality and were taken into account while formulating site, crop and farmer specific strategies for preparedness to deal with occurrences and also for developing policies for providing institutional support.

Table 1: Socio-economic Feature of the Barangays

Site Description	Buhi, Cam. Sur			Guinobatan, Albay			Gubat, Sorsogon		
	San Ramon	San Buena	Igbac	Masarawag	Mauraro	Minto	Rizal	Ariman	Bagacay
Population	1,527 (75% are IPs)	2,532	1,506 (Majority are IPs)	3,802	5,746	1,783	2,610	1,568	3,309
No. of Households	279	450	263	859	919	394	623	314	686
Primary Income Source	Farming	Tilapia fishing, Fish peddling	Farming	Farming	Farming, Abaca handicraft making	Farming, Wage labor	Farming, Fishing, Shell craft making	Farming, Fishing	Farming, Fishing, Fish peddling
No. of Farmers	230	66	220	456	274	123	355	251	249
Total Land Area	468.00 has.	32.98 has.	824.50 has.	859 has.	655 has.	869 has.	584.46 has.	238.72 has.	581.54 has.
Area Devoted to Agriculture	423.50 has.	14.00 has.	711.00 has.	796.00 has.	562.00 has.	400.50 has.	381.35 has.	225.53 has.	450.30 has.
Predominant Crops	Coconut Rice, Root crops, Banana	Root crops, Rice	Corn, Root crops, Coconut, Rice, Banana, Coffee,	Coconut, Vegetables, Rice	Corn, Coconut, Vegetables Rice	Rice, Coconut, Root crops, Vegetables	Rice, Coconut, Root crops, Banana	Root crops, Rice, Banana, Pili	Root crops, Rice, Banana, Vegetables
Existing Cropping System	Mono cropping	Mono cropping	Mono cropping	Mono cropping	Mono cropping	Mono cropping	Mono cropping	Mono cropping	Mono cropping

An in-depth assessment was conducted from a list of potential good practice technologies and processes to identify suitable good practice options to enhance the resilience of the targeted sites. The assessment of the selected good practices for the specific area were designed to increase climate resilience of farming and livelihood systems while contributing to socially, economically and ecologically sustainable rural development.

As part of the major approach undertaken, an on-farm field demonstration was done for three consecutive cropping cycles by selected farmer cooperators in the project sites. Each farmer was provided with inputs from a variety of vegetable seeds, like squash, eggplant, pole sitao, ampalaya, peanut, corn, cassava and sweet potato root crop cuttings, etc., as planting materials sourced out from the partner-agency, the Department of Agriculture Regional Field Office V, at Pili, Camarines Sur. The farmer-cooperators were made to choose what crops to adopt depending on the site of their farm and plant them on a 1,000 square meter farm lot. Alongside the demonstration plot with a variety of at least two crops, farmers were also allowed to plant their own crop applying common farming practices adopted by them to show comparison. All the crops planted were subjected to a production implementation guide for the farmers to follow for consistency and recording observation purposes from planting to harvesting.

RESULTS AND DISCUSSION

Generally, the municipal sites have mountainous and hilly surfaces. Buhi is located in the southwestern tip of the province of Camarines Sur. Its lake is home to the world's smallest commercial fish, locally known as "Sinarapan" (*Mystychtis luzonensis*). Guinobatan is one of the municipalities of the province of Albay that is lying on the foot of the famous Mayon Volcano, one of the world’s perfect coned volcanoes. Gubat, however is one of the five municipalities in the province of Sorsogon situated along the coast of Sorsogon Bay.

Table 2: Climatic Parameters and Hazards

Site Description	Buhi, Camarines Sur			Guinobatan, Albay			Gubat, Sorsogon		
	San Ramon	San Buena	Igbac	Masarawag	Mauraro	Minto	Rizal	Ariman	Bagacay
Average Temperature	29.2° C high	29.2° C high	29.2° C high	33.15° C high	33.15° C high	33.15° C high	32.80° C high	32.80° C high	32.80° C high
	24.7° C low	24.7° C low	24.7° C low	22.60° C low	22.60° C low	22.60° C low	21.90° C low	21.90° C low	21.90° C low
Average Rainfall	261.00 mm	261.00 mm	261.00 mm	331.70 mm	331.70 mm	331.70 mm	337.00 mm	337.00 mm	337.00 mm
Lowest	133.00 mm in April	133 mm in April	133 mm in April	146.80 mm in April	146.80 mm in April	146.80 mm in April	134.80 in April	134.80 in April	134.80 in April
Highest	389.00 mm in Dec.	389.00 mm in Dec.	389.00 mm in Dec.	515.60 mm in Dec.	515.60 mm in Dec.	515.60 mm in December	539.20 in December	539.20 in December	539.20 in December
Hazard/ Risks Identified	Typhoon Flash floods, Lahar flow, Habagat (Jul. to Dec.), Amihan (Dec. to Mar.), Steep/ Sloping Land, Drought	Typhoon, Flooding, Strong winds occur Sept. to Feb., Prevailing year-round abnor-mal climatic condition	Typhoon Flash flood, Soil erosion	Typhoon, Flash floods, Lahar flow, Habagat (Jul. to Dec.), Amihan (Dec. to Mar.), Steep/ Sloping Land,	Typhoon, Soil erosion, Flooding, Tungro, Rat infestation	Typhoon, Flash floods, Soil erosion, Drought	Typhoon, Flooding, Saline water intrusion	Typhoon, Flooding, Saline water intrusion	Typhoon, Flooding, Saline water intrusion

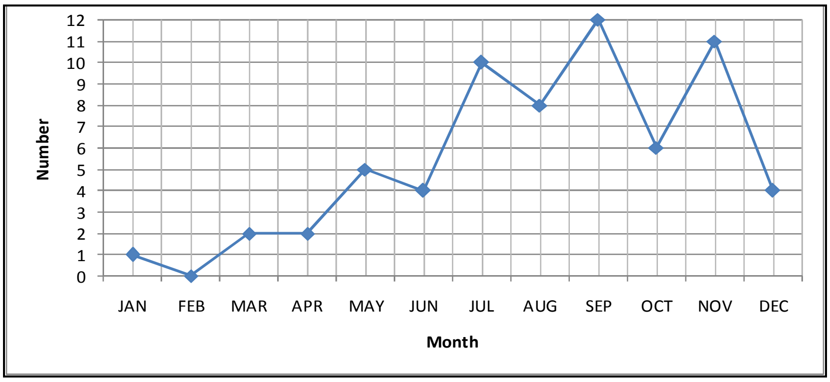

Figure 1: Cumulative number of Tropical Cyclones or Weather Disturbance that had either landed or crossed the Philippines for the last five years (2005-2009)

In terms of barangay population, the most inhabited is Barangay Mauraro of Guinobatan with 5,746 compared to that of Barangay Minto of the same municipality with only 1,783. San Ramon and Igbac of Buhi have 1,527 and 1,506 inhabitants, respectively of which majority belong to the group of Indigenous People (IPs) locally called “Agta”. As to the number of households, Mauraro and Guinobatan have the highest number of households which is 919 and 859, respectively and the least number belong to Igbac and San Buena of Buhi town which has 263 and 279. The data shows that the upland study sites are less inhabited since they are situated far from the urban centers of the municipalities (Table 1).

Apart from farming which is the main source of income of the households, other inhabitants also focus their attention to fishing and fish peddling and some devote to handicraft making as their source of livelihood. In terms of the number of farmers per municipality site, Gubat have the most number which totals to 855, Guinobatan having 853, while Buhi have the least number totaling to 516 farmers approximately for its three barangays.

Table 1 also shows that a major part of the land in the study areas (3,964.18 hectares or 77.53%) is devoted to agriculture. Almost half (41.86%) is devoted to coconut production and about one fourth (24.82%) to rice production. In terms of area devoted to agriculture across sites, Barangay Masarawag in Guinobatan has the largest with 796 hectares of agricultural land, 65% of which is devoted to coconut production; Barangay Igbac in Buhi is next with 711 hectares of agricultural land, 70% of which is devoted also to coconut production; and Barangay Bagacay in Gubat Sorsogon has the highest agricultural area in the municipality measuring 450.30 hectares, 68.5 % of which is utilized for coconut production. The largest area for rice production is in Barangay Mauraro covering 445.6 hectares followed by Masarawag with 222.75 hectares, Igbac with 200 hectares and Bagacay with 127 hectares.

Aside from producing the predominant crops which are rice, corn, and vegetables, people are also engaged in alternative means of livelihood. Some are into poultry and livestock raising (cow, carabao, goat, and swine); others are into copra making; charcoal production; gathering and selling of minor forest products like bamboo and firewood; spear fishing; and re-trading of agricultural produce. Almost all the farmers in the barangays were observed to practice the age-old and traditional mono-cropping system consisting of a single crop, whether rice or any single vegetable or root crop planted on their farm lot.

The climatic parameters and the hazards or risks identified in the barangays are presented in Table 2. Annually, the highest average surface temperature in the province of Camarines Sur is 31.70°C recorded in the month of May and June. The lowest was recorded in the month of February at 21.68°C. During the dry season (Dec-Apr), the highest average surface temperature in the province is 31.40°C and the lowest is 21.68°C while in the wet season, highest average is 32.60°C and the lowest is 23.15°C. For Albay province, the highest and lowest recorded average surface temperatures for the period covered were 32.40°C in May and 22.30°C in February, respectively. Highest and lowest average temperatures during the dry season (Dec-Apr), were 31.40°C and 21.68°C, while during the wet season, these were recorded at 32.60°C and 23.15°C respectively. In Sorsogon, recorded maximum average temperatures were almost the same with that of Albay at 32.8°C in the months of May, June and August. The lowest recorded average surface temperature was 21.9°C in February to March. Comparing the average surface temperatures in the three provinces covered by the project, in can be noted that the coolest province is Camarines Sur (http://www.pagasa.dost.gov.ph).

As to the amount of rainfall, the highest recorded in the province of Camarines Sur, for the past 16 years (1984-2000) was during the month of November with 305.95 mm and the lowest during the month of March with 50.09 mm. From the month of January to April, the province receives less than 100.00 mm of rainfall which means that within the dry season it is only during the month of December that Camarines Sur is receiving sufficient amount of rainfall with an average of 217 mm per month. In the province of Albay, the average monthly rainfall recorded for the past 35 years (1965-2000) is more than 100.00 mm year round. The highest amount of rainfall occurs in December (515.60 mm) and the lowest in the month of April (146.80 mm). Albay province receives more than 200.00 mm of monthly rainfall from July to December. For the past 35 years (1965-2000), the province of Sorsogon has a similar indicating pattern for its average monthly rainfall. The highest amount falls in December (539.20 mm) and the lowest in the month of April (134.80 mm). The figure also reveals that Sorsogon starts receiving more than 200.00 mm of rainfall from September to February (Table 2).

Table 3: Good Practices Options Identified for the Upland Ecosystems

	Diversified Strip Intercropping	**Coconut Leaf Pruning**	**Use of Drought Tolerant Crops**	**Mulching**
Description	The practice of producing two or more crops in narrow strips located throughout the length of the field. The strips are wide enough that each can be managed independently, yet narrow enough that each crop can influence the microclimate and yield potential of adjacent crops. Crops can be rotated annually.	Coconut (*Cocos nucifera*) leaf pruning (CLP) involves the removal of the older leaves of the crop and maintaining only the desired number of leaves to reduce the effective transpiration surface area. In bearing palms, any of the 13, 18, or 23 functional upper leaves of the tree crown may be retained.	The use of drought tolerant crops adopting the practice of zero to minimum tillage to reduce soil and water losses. This refers to sowing of crops directly into the residue of the previous crop without cultivation. In contrast, minimum tillage refers to the reduction in the frequency of tillage operation and the degree of cultivation in the crop production systems. Usually, only a single light cultivation of a limited area of the soil surface is used to prepare an area for planting.	Mulching is the process of spreading organic mulches from plant residues (leaves, stalks, crowns, roots, straws, woodchips, and sawdust) and synthetic materials (plastic sheets, aluminum foil, kraft paper, and newspaper) over the ground between crop rows or around tree trunks to protect and conserve the soil.
Location where the GP Option can be applied	- Guinobatan (Minto, Mauraro, Masarawag) - Buhi (San Ramon, Igbac, San Buena) - Gubat (Bagacay, Ariman, Rizal)	- Guinobatan (Minto, Mauraro, Masarawag) - Buhi (San Ramon, Igbac) - Gubat (Ariman, Rizal, Bagacay)	- Guinobatan (Minto, Mauraro, Masarawag) - Buhi (San Ramon, Igbac) - Gubat (Bagacay, Ariman, Rizal)	- Guinobatan (Minto, Mauraro, Masarawag) - Buhi (San Ramon, Igbac) - Gubat (Ariman, Rizal, Bagacay)
Sustainability by hazard	Drought, Continuous rain, Strong winds	Drought, Strong winds	Drought, Strong winds	Drought
Environmental suitability	Flat and sloping land	CLP may be applied to other younger stages of the coconut plant (nursery seedlings, seedlings for field planting, young plantings and immature, or non-bearing palms) subjected to long, dry season.	Can be planted any time of the year in areas where there are no distinct wet and dry seasons and rainfall is evenly distributed.	Mulching are highly applicable in drought-affected areas. Mulches can be applied in vegetable beds, gardens, orchards and post-rice crops.
Contribution to disaster risk reduction	Prevention and mitigation	Mitigation	Mitigation	Mitigation
a. Agro-ecological suitability	High	High	High	High
b. Economic and social feasibility	High	High	High	High
c. Increased	High	High	High	High

resilience against hazard				

	Diversified Strip Intercropping	**Coconut Leaf Pruning**	**Use of Drought Tolerant Crops**	**Mulching**
d. Does not contribute to greenhouse gasses (GHG)	High	High	Medium	High
Contribution to disaster reduction / prevention	• A well-designed system has a greater soil and water con-servation potential than most mono-cropping systems. • A well-managed strip inter-cropping system results in higher crop yields and greater profitability than mono-cropping systems • Increases farm resilience	• Reduces water requirement of the crop because of reduction of the transpiration surface (less functional leaves) and volume of water loss • Minimizes crop damage, particularly on flowering, fruit set and yield • Increases sunlight transmission below the tree canopy resulting in higher solar energy for and better yields of the intercrops (e.g., corn yield under coconut with CLP = 3.71 t/ha vs. coconut without CLP = 2.16 t/ha) • Pruned leaves (9-15) during initial CLP can be used as mulching materials	• Drought impact reduction, crop loss reduction, maximization of soil moisture use	• Reduces soil erosion • Improves moisture retention • Allows build-up of organic materials • Suppresses growth of weed by blocking out sunlight • Serves as insulator that keeps soil cool under intense sunlight and warm during cold weather • One of the disadvantages though when using plastic mulches for long periods may lead to poor soil

Regarding typhoon pattern and occurrence in the Philippines, the ten most intense typhoons that affected the Bicol Region occurred from 1988 to 2006. Half of these number happened during the months of November. The Typhoons with the highest wind speed (more than 200 km/hr) were experienced in the Bicol Region during the months of October and November. The most intense Typhoon ever recorded that affected the Bicol Region was Super Typhoon Reming (Durian) in the year 2006 with wind speed up to 320 km/hour. The graph below (Figure 1), taken from the Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA) of the Department of Science and Technology (DOST), a government institution which provides public weather forecasts, flood and typhoon advisories and other climatological data, shows the cumulative number of weather disturbances that had either landed or crossed the country within the last 5 years (2005-2009).

It can be gleaned from Figure 1 that most weather disturbances have its peak of occurrence during the months of July, September and November. It was noted that the month of September has its highest number of typhoon occurrence having a total of 12 recorded for the past five years.

Table 4: MBCR of Farmer's Practice and the GP Options

Site	Wet Season (Oct - Feb 2010)			Dry Season (Apr - Aug 2011)			Wet Season (Aug - Dec 2011)		
	Farmer's Practice	GP Options	MBCR	Farmer's Practice	GP Options	MBCR	Farmer's Practice	GP Options	MBCR
Buhi		**Strip Cropping**			**Strip Cropping** (LD or MD + SD)			**Coconut Leaf Pruning**	
	Upland Rice (Local Variety)	NSIC RC 9 (*Apo*) + Sweet Potato 17	1.36 (n=5)	LD (Eggplant)	Snap Bean	4.80 (n = 3)	Sweet Potato (*Tres colores*	Sweet Potato 23	2.07 (n = 3)
				LD (Cassava)	Pole Sitao	2.97 (n = 2)			
				MD Okra	Snap Bean	3.91 (n = 2)	Cassava (*Local variety*)	Golden yellow	3.90 (n = 1)
					Pole Sitao	2.16 (n = 2)		Squash (*Rizalina*)	2.42 (n = 2)
Guinobatan		**Coconut Leaf Pruning**			**Coconut Leaf Pruning**			**Strip Cropping** (LD or MD + SD)	
	Corn (*Local*	Corn (*Super sweet*)	2.81 (n = 2)	*Local variety*	Peanut (*Biyaya*)	4.73 (n = 4)			
				Local variety	Corn (*Lagkitan*)	3.65 (n = 5)	Corn (*Local var.*	Peanut (*Biyaya*) + Super sweet corn	5.58 (n = 6)
					Eggplant (*Morena*)	2.14 (n = 2)	Eggplant	Eggplant + Pole sitao (*Mabunga*)	3.32 (n = 4)
								Eggplant + Upo (*Tambuli*)	1.94 (n = 3)
Gubat		**Strip Cropping** (MD + SD)	MBCR		**Strip Cropping**			**Strip Cropping**	
	Corn (*Local variety*)	Corn (*Lagkitan*) + Pole Sitao (*Arayat green*)	3.66 (n = 5)	Okra	Okra (*Smooth green*) + Pole Sitao (*Mabunga*)	3.49 (n = 5)	SD (Corn)	Eggplant (*Morena*) + Okra (*Smooth green*) + Corn (*Super sweet*)	2.99 (n = 6)
				Eggplant	Eggplant (*Morena*) + *Okra (Smooth green) Pole Sitao (Mabunga)*	4.29 (n = 3)	LD (Eggplant)	Eggplant (Morena) + Pole sitao (Mabunga)	4.74 (n = 6)

With the above findings and the recently observed general climatic conditions in the Bicol Region where there is usual monsoon activity and the triggering occurrence of the El Niño/La Niña-Southern Oscillation (ENSO) characterized by variations in the temperature of the surface and a higher number of typhoons in the tropical eastern Pacific Ocean, coping strategies in upland agriculture in order to mitigate climate risks were analyzed. It can also be noted that the ENSO causes extreme weather conditions in many regions of the world which brings about drought, heavy rains and floods affecting areas dependent upon agriculture (http://en.wikipedia.org). An evaluation of the selected good practices for the specific areas and barangays were also adopted using the Livelihood Adaptation to Climate Change (LACC) framework adopted and designed to increase climate resilience of farming and livelihood systems while contributing to socially, economically and ecologically sustainable rural development (http://www.fao.org/climatechange/laccproject).

Coupled with the usual practice of farmers during calamities with regards to the management of their crops, the study initiated the documentation of a wide range of good practices to reduce the risk of hydro-meteorological hazards especially in the upland and rainfed areas. The practices identified and selected from among others were related to typhoons, soil erosion due to heavy rainfall, and drought. These are: diversified strip intercropping, coconut leaf pruning, use of drought tolerant crops and mulching.

Strip intercropping is the practice of producing two or more crops in narrow strips located throughout the length of the field. The strips are wide enough that each can be managed independently, yet narrow enough that each crop can influence the microclimate and yield potential of adjacent crops. Crops can be rotated annually. Strip intercropping use is normally based on agronomic and/or environmental considerations. A well-managed strip intercropping system results in higher crop yields and greater profitability than monocropping systems. Environmentally, a well-designed system has greater soil and water conservation potential than most monocropping systems.

Coconut leaf pruning (CLP) involves the removal of coconut leaves to allow adequate sunlight for the normal development and high yield of perennial and annual crops. This production strategy offers an alternative source of producing coconut pith without cutting the existing productive coconut trees. This could contribute to the conservation of natural resources such as coconut trees, thereby maintaining the natural balance of the ecosystem. Likewise, with the increasing demand of vegetable food items in a growing population, the scheme is adopted for production with existing coconut-bearing trees (Table 3).

The use of drought tolerant crops especially for grain and legumes are vital sources of low-cost protein in the upland. The sale of excess grain generates significant farm income. Grain legumes also help restore soil fertility, since their roots fix nitrogen from the air in forms that can be used by subsequent crops. Likewise, the stems and stalks of these crops are valued as livestock feed. Peanut is the most widely grown legume in the dry areas of Bicol. Drought-tolerant crops were likewise recommended for application as this will pave way on the adoption of the good practices options per barangay and municipality.

Mulching is one of the simplest and most beneficial practices that can be adopted in the upland farm areas. Grass clippings make excellent mulch. They are easy to spread between small vegetable plants. The grass in the farm lots make a steady supply to layer on throughout the summer. Mulching helps preserve water and regulate the temperature in the soil but it also prevents the growth of weeds, protects soil from compaction, cuts down on erosion and, if organic, it produces feeds your soil. As the mulch decomposes, it provides that vital organic matter to the soil, encourage microbe growth and shelter earthworms. The organic matter keeps the soil loose so that it can retain moisture and promote root growth.

The above enumerated good agricultural practice options are a collection of principles to apply for on-farm production and post-production processes resulting in safe and healthy food and non-food agricultural products, while taking into account its agro-ecological suitability, economic and social feasibility, technology which does not increase greenhouse gas emissions, and increases resilience against impacts of climate hazards (Table 3).

In addition to the good practice options identified for adoption in the upland areas, farm record keeping was likewise introduced as part of the capacity building activities undertaken for the farmers across the sites. Farm record keeping will assist the farmers' knowledge when a certain crop or crops are in demand in the market. Through their records, farmers could monitor the price difference of various products. In this manner, the farmers can program their production to obtain the best price available over time. Hence, an increase in farm profitability and an enhanced decision making process.

After the good practice options were identified, training on site were conducted to strengthen the capability of the farmer cooperators in implementing the good practice options to reduce the risk of hydro-meteorological hazards in the upland agroecological zones of three pilot barangays of Buhi, Camarines Sur, Guinobatan, Albay, and Gubat, Sorsogon. The good practice options that were established in the farmer-cooperators' farmlots served as demonstration plot in raising the awareness of other farmers on how to reduce the risk of hydro-meteorological hazards in their sector.

Complementing the good practice options implemented by the farmers is a regular farm weather forecast. These are agri-weather tips and advisories mainly focusing on giving information or instructions on what farmers should do given a certain climatic condition in their area. These may range from providing the agro-climatic information and some analysis on how the situation will affect the farmers' farm and their crops. Some information on soil moisture conditions, or tips whether to harness rainfall during rain occurrences to be the source of water during its absence and advisories on fishing. Likewise, information on monitoring of pests and diseases and harmful animals which may affect the day-to-day farming activities is also included. The forecast is derived from PAGASA-DOST and interpreted by the Department of Agriculture Region Field Office V (DARFU-V) and issued to the Provincial and Municipal Agricultural Offices to be shared to the farmer clientele through the media using radio and television. The farm weather forecast is usually given in the vernacular to be farmer-friendly and easy to understand. This may range from a weekly to a ten-day farm weather bulletin.

Making the needs of the farmers' intent to maximize production out of the amount of input derived and getting as much as from the minimum amount possible is every farmer's target. From the least amount of input, farmers want to get the maximum of production as much as possible. Discovering the correct ratio of inputs versus outputs to receive the most benefit from the effort is the most important concern from the farmer's perspective. The use of the marginal benefit cost ratio (MBCR) using the formula below was adopted for analyzing an adaptation measure by identifying, quantifying, and monetizing the costs and benefits associated with the measure:

$$MBCR = \frac{Additional\ Benefit}{Additional\ Cost} = \frac{Sales_{GPO} - Sales_{FP}}{Production\ Cost_{GPO} - Production\ Cost_{FP}}$$

Cost benefit analysis estimates and totals up the equivalent money value of the benefits and costs of the good practice options and the farmers' practice whether they are worthwhile. The most convenient common unit is money. This means that all benefits and costs of the GP options per demonstration farm should be measured by their equivalent money value (http://mba651fall2007.wikispaces.com).

The cost benefit analysis was useful as the adaptation being considered involves significant expenditures of farm labor and the amount of investment. A cost benefit analysis is useful when the adaptation being considered is likely to involve significant expenditures of capital and labor. MBCR was used to determine whether the benefits of the adaptation measure outweigh the costs, whether net benefits are maximized, and how the good practice options compare with the farmers' practice.

The marginal benefit cost ratio (MBCR) as shown in Table 4, comparing the farmer's practice versus the good practice options have been very useful in showing the difference if the farmers were still to follow the age-old tradition of mono-cropping system. Although, at the onset of the wet season covering the months of October to February 2010, crops in the demonstration farms of some areas were damaged due to excessive rain caused by La Niňa. However, in Buhi, the NSIC RC9 (*Apo rice variety)* combined with sweet potato (*variety 17)* have exceled in terms of yield performance against the upland rice (*Local variety*) with an MBCR of 1.36 from five farmer-cooperators. In Guinobatan, the performance of the *super sweet* corn variety over the *local* corn variety using farmer's practice have shown to be promising as it derived an MBCR of 2.81 from two farmer-cooperators utilizing the coconut leaf pruning

GP option. In Gubat, under the strip cropping GP option, the combination of the l*agkitan* corn variety and the *arayat* pole sitao variety from five farmer-cooperators showed an MBCR of 3.66 over the *local* corn variety using the farmer's practice of mono-cropping system. This option have integrated two crops, one which is a medium-duration (MD) crop (corn) and another, which is pole sitao, a short duration (SD) crop.

During the dry season of 2011, which covers the months of April to August, the strip cropping GP option adopting the combination of either a long duration (LD) crop or a medium duration (MD) crop plus a short duration (SD) crop have performed fairly well over the farmer's practice in the three municipalities. Taking the case of three farmer-cooperators in Buhi which planted eggplant - a long duration (LD) crop as farmer's practice as compared to the ones who planted snap beans under the GP option on strip cropping have derived an MBCR of 4.80. For those who planted cassava in Buhi from the farmer's practice as against the two farmers adopting the GP option for pole sitao have achieved an MBCR of 2.97. Comparing the farmer's practice which adopted okra as a medium duration (MD) crop over the combination of snap beans and pole sitao as GP option have also realized an MBCR of 3.91 and 2.16 for snap beans and pole sitao, respectively.

Under the coconut leaf pruning GP option in Guinobatan, the *biyaya* peanut variety has performed well in terms of yield over the local variety which showed an MBCR of 4.73 from four farmer adopters. Likewise, the combination of the *lagkitan* corn variety and the *morena* eggplant variety was found to perform well achieving an MBCR of 3.65 and 2.14, respectively against the performance of the single local variety corn crop from the adoption of the farmer's practice. The strip cropping GP option for the crop combination of the *smooth green* okra variety plus the *mabunga* pole sitao variety have been found to perform well with 3.49 MBCR from five farmer-cooperators over the farmer's practice adopting only okra as single crop. Likewise, the crop combination of *morena* eggplant variety plus *smooth green* okra variety and *mabunga* pole sitao variety have achieved an MBCR of 4.29 from three farmers as against the single local eggplant crop variety as farmer's practice.

The third copping cycle covering the wet season for the months of August to December 2011, the coconut leaf pruning GP option for Buhi have also shown a significant performance particularly the adoption of the sweet potato *variety 23* for which have derived an MBCR of 2.07 over the farmer's practice of only using the local tres colores sweet potato variety. The *golden yellow* cassava variety and the *rizalina* variety of squash have also achieved an MBCR of 3.90 and 2.42, respectively over its farmer's practice counterpart of only adopting the local cassava variety in Buhi.

The strip cropping GP option for the wet season 2011 combining a long duration (LD) or medium duration (MD) plus a short duration (SD) crop were also observed to perform well in the demonstration farms in Guinobatan. The *biyaya* peanut variety plus super sweet corn combination showed a significant result in terms of MBCR with 5.58 from six farmer cooperators over the single crop which is the local variety of corn under the farmer's practice category. The combination of eggplant plus *mabunga* pole sitao variety which gained an MBCR of 3.32 from four farmer adoptors and the combination crop of eggplant plus *tambuli* upo variety which derived an MBCR of 1.94 with three farmer-cooperators over and above the farmer's practice of adopting the single crop which is only eggplant though considered as a long duration (LD) crop. Adopting the multi-cropping system and diversifying the crop durations have been very beneficial for the farmers as compared to the previous practice of production from the mono-cropping system of farming in the upland areas. Likewise in Gubat, six farmers have proven that combining three crops (*morena* eggplant plus *smooth green* okra plus *super sweet* corn) in one farm under the strip cropping GP option is possible as the crop combination have derived an MBCR of 2.99 over the single crop local corn variety as farmer's practice. The combination of *morena* eggplant plus *mabunga* pole sitao variety have also proven to perform well with an MBCR of 4.74 from six farmers cooperators over the framers' practice of adopting only eggplant as single crop (Table 4).

CONCLUSIONS

Carefully choosing the long, medium or short duration crop combinations and introducing the change in crop varieties have shown to be a very useful approach in achieving outputs which were very beneficial to the upland farmers in terms of production. Planting of various crops have proven to reduce the risks of damage in terms of its maturity. The timing of planting was also crucial. In the case of the GP options that were adopted, the variability of the climate which abruptly changed from wet to very wet weather conditions across the sites, in the duration of the study, were indicators when farmers will start to plant or do land preparation activities. The integration of different crop durations adopted in the farms were also helpful in terms of timing of planting and harvesting. Since the farmers, long before, have been with their usual practice of planting the same crops, it was not difficult for them to implement appropriate crop management protocols. The rainfall forecasts by PAGASA which were interpreted in terms of farm weather updates and tips for farmers by the Department of Agriculture Regional Field Office V technical personnel and disseminated through the municipal agricultural offices enabled the farmers to determine a more accurate action to cope with the adverse weather conditions in the upland areas. These were location-specific rainfall forecasts which facilitated the farmers' judgment on what farming activities to undertake. It was vital for the farmers to implement properly the procedures that were emphasized for them in adopting the GP options through the series of training activities. Closely monitoring the crops, the farming activities and exercising peer pressure have also helped in achieving the targeted outputs in terms of production. The farmers took only what they perceived to benefit them in terms of choosing what varieties of crops to plant given a particular cropping season. The sustainability of the good practice options depended on the specific agro-meteorological and location characteristics. There was no "one fits all" practice as the options depended on what the farmers wanted to adopt. Integrating these farmer preferences combined with updated farm weather bulletins and the change in crop varieties were the vital challenges in strengthening the adaptation potentials for the disaster risk reduction coping mechanisms in the upland ecosystems achieving economic benefits to the farming households.

RECOMMENDATIONS

The study sites have many characteristics in common such as prevalence of extreme vulnerability and limited capacity of managing risks and disasters, dependence of the local communities to farming, mono-cropping system, cropping calendar and the kind of crops cultivated, exposition and extreme vulnerability to typhoons, continuous rains, soil erosion and flash floods. These similarities on many levels support the use of a similar strategic approach in the study sites as far as farming systems is concerned. Recognizing that climate change could have negative consequences for agricultural production, the diversification of crops can improve farm resilience by buffering crop production from the effects of variability in climate and other extreme events in the upland areas. Farming diversification provides a variety of produce for food and livelihood. It is therefore advised that the good practice options be replicated and mainstreamed with the integration of livestock at the local and community levels to enhance climate change and disaster risk reduction coping mechanisms. The various cassava and sweet potato varieties, which are alternative sources of carbohydrates, can still be harvested after typhoons or heavy rains. The change in crop varieties was beneficial as it reduced production risk thereby increasing farm productivity and sustainability for the upland farming households. The mechanisms and approaches applied at the farm level contributed to the maximized use of land as the primary resource which likewise contributed to an increase in income as shown in the various computations on the marginal benefit cost ratios per demonstration farm. The location specific rainfall forecasts and the regular dissemination of farm weather updates also enabled the farmers to adopt a more accurate action to cope with climate risks and weather variability.

ACKNOWLEDGMENTS

The collaborating institutions (FAO, Bicol University, DA-RFU5, PAGASA-DOST, CBSUA) who were involved in the implementation of the Bicol Region FAO-TCP/PHI/3203 Project with the special mention of the Local Government Units of Buhi, Camarines Sur; Guinobatan, Albay; and Gubat, Sorsogon and the various barangay officials and farming communities are gratefully acknowledged for their participation in the whole process from planning to evaluation.

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