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Climate Risk Profiles for a Climate-Resilient Agriculture on Selected Crops in the Cordillera Administrative Region

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Abstract

This research identified the climate change risks and responses along the rice, yellow corn, potato, and cabbage value chains and recommended Climate-Resilient Agriculture (CRA) options as prioritized by stakeholders. The key climate hazards affecting agriculture in the Cordillera Region are tropical cyclones or typhoons and drought. Lowland rice farming communities are vulnerable to flooding caused by heavy rains while highland vegetable and upland corn farming communities are vulnerable to soil erosion, landslides, and strong winds. Farmers' mitigating measures against soil erosion, landslides, and flooding include cleaning the drainage canals. Farmers with no access to water resources delay planting or adjust their cropping calendar to ensure crop survival during prolonged drought. They utilize rain-water harvesting tanks or dig deep wells and use water pumps to draw water for crops. Other mitigation measures include: construction of crop shelters or greenhouses to protect crops from strong winds and heavy rains, employing organic farming to reduce the undesirable effects of conventional farming to human health and the environment, using botanical attractants in controlling pests, and integrating livestock and crops to maximize land use and ensure food security for the household. Cost and low awareness on climate change are the major barriers to the adoption of climate resilient technologies. Most farmers have limited financial capacity and not aware of technical information on climate change. High cost of production, absence of policies to stabilize market price, non-observance of quality standards and good production practices, lack of coordination among farmers and lenient enforcement of standards by the government are prevailing concerns of stakeholders. Government programs are continually designed for farmers, but, the process and requirements hinder some farmers from availing of the programs.

KEYWORDS

Climate hazard
Tropical cyclone
Drought
Food security
Climate resilient technologies

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Introduction

Luzon had the biggest contribution to the country's total agricultural production in 2017 at 50%. In all subsectors, it contributed a share of almost 44% on crops, 57% on livestock, 66% on poultry, and 52% on fisheries. Luzon's Gross Value Added (GVA) of agriculture, hunting, forestry, and fishing accounts for 51% of the country's total GVA (Philippine Statistics Authority [PSA], 2017).

The ability of the Philippines to achieve its sustainable development goals is affected significantly by impacts of climate change and natural disasters. The agriculture and fisheries sector are one of the most susceptible to climate change, especially since the sector accounts for a third of the country's total labor force (PSA, 2015). In the Philippines, at least 72.5% of the population is exposed to multiple hazards which include periodic typhoons, tropical cyclones, floods, droughts, earthquakes, tsunamis, volcanic eruptions, landslides, forest-fires and pandemics (Philippine Atmospheric, Geophysical and Astronomical Services Administration [PAGASA], 2011). Natural hazards and disasters cause 22% of the economic impacts to the agriculture and fisheries sector (Food and Agriculture Organization [FAO], 2015). The government estimates that between 2003 and 2013, disasters damaged over 12.2 million hectares of crops amounting to USD 7.1 billion in total damages and losses to the agriculture sector, of which 93% is caused by hydrological and meteorological hazards (Department of Agriculture [DA], 2018). Rice constituted the highest losses (USD 3.0 billion), where most of the losses were registered in the areas of Central Luzon, Cagayan Valley and Bicol Region (DA, 2018).

Damage and losses to the agriculture sector is expected to be further exacerbated as temperature and rainfall are expected to increase in the future due to climate change. Annual mean temperature in the country had already increased by 0.65°C from 1951 to 2010 (PAGASA, 2011) and downscaled climate change projections for the Philippines indicate a further increase of 1°C to 1.2°C in annual mean temperature from 2020 to 2079 for Representative Concentration Pathways (RCP) 4.5 and RCP 8.5, respectively (PAGASA, 2017). By 2049, a significant shift in temperature is expected in already drought prone areas in the Cordillera Region, Cagayan Valley, Central Luzon, Mindoro Island and most of Mindanao Island from March to August (PAGASA, 2017).

Generally, food and agriculture systems are projected to be negatively impacted by climate change (Intergovernmental Panel on Climate Change [IPCC], 2014). Major food crops in tropical and temperate regions will have decreased yields with temperature increase of more than 2°C (IPCC, 2014). Farmers and fisherfolks will need to adopt different cropping patterns, stress tolerant varieties, modified soil and water management, and farm management practices, based on area and crop specific climate predictions to better adapt to these changes, both in the short and long term. Appropriate climate resilience responses for different crops and where, have been analyzed by International Center for Tropical Agriculture [CIAT] (2017) as to their suitability, uptake and effectiveness for adaptation.

Over the past years, farmers have seen unequivocal changes in weather patterns which had a major to severe impact on the various activities in the value chain of major crops. This warrants the need to assess the vulnerability and adaptive capacity of key players. The general aim of the project is to examine the vulnerability, exposure and adaptive capability of stakeholders to climate change for evidence-informed investment planning and decision-making as well as reduce the effect of climate variability on rice, yellow corn, potato and cabbage farming systems. Specifically, it aimed to identify key climate change risks and responses along the four stated value chains and recommend Climate-Resilient Agriculture options as prioritized by the stakeholders.

Methodology

The project assessed the climate risk vulnerability of stakeholders in four value chain activities specifically: (1) provision of seeds and other inputs; (2) on-farm production; (3) harvesting, storage and processing; and (4) product marketing.

Four major commodities namely rice, yellow corn, cabbage and white potato were the crops

considered in two study areas. Area 1 of the study is composed of the rice and corn producing provinces of Abra, Apayao, Ifugao, Kalinga and Mountain Province while Area 2 is represented by the province of Benguet, being the major producer of cabbage and white potato in the Cordillera Administrative Region.

Research Design

The project is qualitative research in which the data collected is mainly text-based and unstructured.

Respondents of the Study

Respondents of the study are representatives of each stage in the value chain composed of input suppliers, farmers, market agents, and processors. Key informants from concerned private and government agencies were also involved in the validation of data gathered.

Instrumentation and Data Gathering

A semi-structured survey questionnaire was used to collect information from the identified respondents while desktop review was employed to gather secondary data. Climate risk vulnerability assessment (CRVA) and profiling of local adaptation and mitigation practices and community-level planning and prioritization of CC technological interventions were done through the following:

i. Conduct of desktop review and gathering of secondary data in which the farming systems and value chains as well as the socio-economic and agricultural profile were assessed and characterized.

ii. Organization of a series of community and stakeholders' meetings and Focus Group Discussions to gather supplementary data, climate exposures and sensitivity and local adaptation and mitigation practices to include perceptions, knowledge and strategies to adapt to climate change.

iii. Conduct of semi-structured survey and workshop with local stakeholders for the identification of local climate change adaptation and mitigation practices and community prioritization of the identified local and potential technological interventions

iv. documentation of CRA practices

v. CRVA preliminary result validation, planning and prioritization of CRA interventions

Data Analysis

Thematic analysis using manual coding was used to identify, categorize and interpret the information gathered from the respondents while narrative analysis was employed to interpret the participants' testimonials and insights during the focus group discussions.

Results and Discussions

Climate Risk Profiles for a Climate-Resilient Agriculture on Rice and Yellow Corn Production in Selected Provinces in CAR

Crop Farming System and Value Chain

Rice Farming System. Rice is mostly grown as a monocrop, where rice is planted alone for the entire area two to three times a year. This is the predominant farming system for rice in CAR. Lowland rice farming depends on irrigation with farm operations being both manual and mechanized. The farmers are engaged in conventional farming with the use of synthetic chemicals to fertilize and control pests and diseases.

Another farming system practiced by some farmers is integrated farming where they plant other crops and raise poultry and livestock aside from rice. This is done to maximize use of the land while supplementing their income from the harvest of cash crops or providing their own food for family consumption.

Rice Value Chain Activities. Inputs such as hybrid seeds and synthetic chemicals such as fertilizers, pesticides, and fungicides are provided by agricultural stores. In Abra, some of the established farm stores are Superbreed Farm Supply, Formoso Farm and Poultry Supply, Khaleet Farm Supply, and Banez Commercial. Farm stores in Kalinga include JAC Farms and Oplay Tay-og Farm Supply. Aside from entrepreneurs, there are also government programs which disperse and/or sell seeds and other inputs to farmers through the Provincial and Municipal Agricultural Office from time to time. Farmers' associations, cooperatives, non-government organizations, and Rural Improvement Council provide technical, financial, or livelihood assistance to their members.

Government line agencies from national to municipal level offer financial and credit services to farmers following prescribed protocols through their organizations.

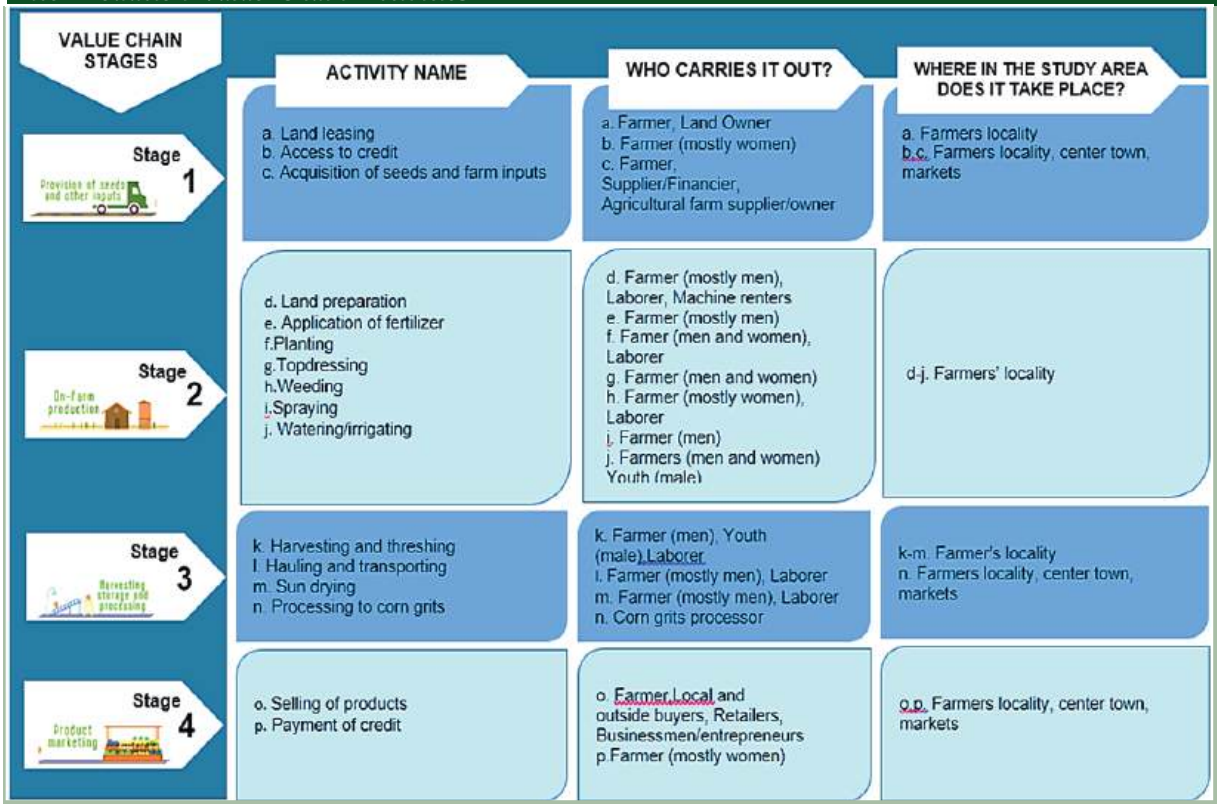
Farmers do the labor from land preparation to harvesting. Land preparation, broadcasting of seeds in seed beds or rice fields, spraying, and irrigating are done mostly by male farmers. Female counterparts help in planting and manual weeding. Farmers with a wide land area hire laborers mainly during land preparation and harvesting. They hire rotavators for plowing and harrowing during land preparation and combined-harvesters in time of harvest (Figure 1).

Farmers sell rice paddies in fresh and dried weight to traders or middlemen who usually go around the locality during harvest time. Other farmers have their own contact with traders or middlemen. The price of rice paddy depends on the quality. Established traders process the rice paddies from milling to packaging while the rest sell the rice paddies to local and outside buyers. The packaged rice is sold to retailers within and outside the locality. The National Food Authority (NFA) is one major buyer of rice. Bulk rice products in the region are also displayed by retailers in Benguet and Baguio City. These retailers then download these products to consumers in the market.

Yellow Corn Farming System. Upland yellow corn is grown in either monocrop systems, intercropping systems, rotational cropping, and multiple cropping systems. In the lowland areas, crop rotation is practiced by planting rice after corn. When the corn plants are damaged due to flooding, farmers plant sweet potato and peanut after the flood. Multiple cropping is practiced by corn growers by planting different crops such as vegetables together with corn. Vegetables are planted to supplement income and for family consumption. It is also common for farmers to plant papaya fruit on the boundaries of the field.

Figure 1

Rice Producion Value Chain Activities



Corn production areas are rain-fed, relying on the onset of the rainy season before production operations start. Similar to rice, farm operations can be both manual and mechanized. Majority of the farmers practice conventional farming with dependency on synthetic chemicals to enhance yield and control pests, and diseases.

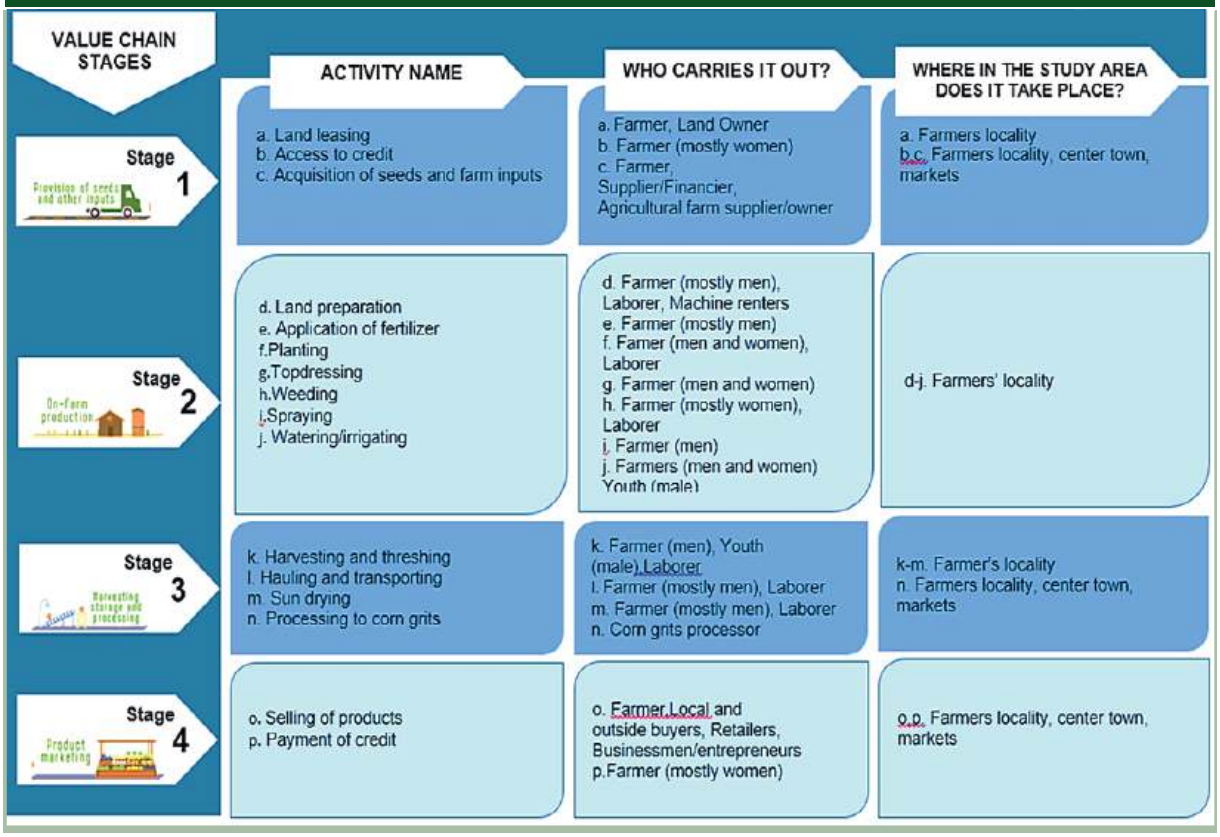
Yellow Corn High-Value Activities. On the provision of seeds and other inputs, agricultural supply stores located in the central towns sell hybrid seeds and synthetic chemicals such as fertilizers, pesticides and fungicides among others to farmers. In Ifugao, established agricultural farm supplies include the Mondiguing Farm Supply, and Fontanilla Farm Supply. There are also some cooperatives in the region who provide loans to farmers. Private cooperatives such as St. William's Multipurpose Cooperative provides loans to corn growers in Paracelis, Mt. Province. However, some farmers prefer instead to obtain their supplies from private trader-financiers in their area on a charge-to-crop credit arrangement or financing system. The financing system through an agreement between a trader or financier and the farmer whereby the financier will provide the agricultural inputs and whatever inputs will be deducted to the gross sales after harvest.

Similarly, the Lamut Grassroots Development Cooperative (LAGSADECO) provides loans to corn growers in Ifugao. There are government programs through the Provincial and Municipal Agricultural Office which disperse and/or sell seeds and other inputs to farmers. There are also other private companies which offer lending services. In addition, agricultural line agencies from national to municipal levels offer financial and credit services to farmers. However, this is done through organization and requires a process. According to the farmers, women or mothers are mostly engaged in accessing credits (Figure 2).

On the production level, men are responsible for land preparation and pest control. Women help in topdressing and in manual weeding. Topdressing is the application of fertilizers into the soil during the growing season in order to improve plant nutrition and boost yield. Male

Figure 2

Yellow Corn Production Value Chain Activities



and female laborers are hired during planting, fertilizer application, weeding, harvesting, threshing, and bagging when family labor is not enough. During harvest, harvester machines may be hired from the owner-entrepreneurs.

Dominantly, poultry and piggery owners buy the corn directly from the farmers. These have their own feed mills and mix their own feeds which are then fed to their livestock. Other entrepreneurs purchase dried corn in bulk and sell them to several retailers. Backyard swine and poultry raisers are considered small-scale buyers who also buy corn directly from the farmers.

Assessment of Climate Hazard

The Climate Farmer's Perspectives on its Impact on Their Livelihood. Normally, Abra and Benguet Provinces have a Type I climate with two distinct seasons-dry seasons from November to April and wet season for the rest of the year; maximum rain period is from June to September. Meanwhile, Apayao is under the Type II climate where there is not a single dry month with a very pronounced maximum rain period from December to February or from March to May. However, some parts of Apayao are covered under Type IV climate which resembles a Type II climate with no dry season but rainfall is evenly distributed throughout the year (PSA, 2020).

Cordillera farmers attested that the climate has really changed. The manifestations are changes in climate patterns such as erratic weather, extreme weather conditions like intensifying and irregular rainfall patterns, intensifying and more frequent typhoons, and prolonged drought season. High postharvest losses in manual drying of corn and rice have been experienced where grains get wet with sudden downpour during the midday. Farmers say typhoons are stronger than before. This results in greater damage on crops which redounds to loss in income. They added that greater damage to human life and infrastructures is now common. In Abra, a rice field which existed for a long time was eventually effaced by the swelling river during strong typhoons in recent years. "The previously farmed lands are now part of the river. There is no possibility of planting any sort of crops since the cropland has become stony and sandy," recalled by "Edhz" (farmer). "Romy" (farmer) adds "Soil erosion is experienced when there is 1-2 days heavy downpour of rain. So, I have to put in a bamboo structure to hold the soil which covers the rice I planted."

On the other hand, farmers claimed there is an increase of temperature during summer which causes wilting and drying up of crops. More frequent watering is needed due to faster evaporation. Farmers claimed that prolonged drought periods cause drying up of creeks and springs and low water level in rivers. A farmer who sources water from a spring to irrigate his farm in the upper elevation of the mountain lamented that it has now dried up. High postharvest losses in manual drying of corn and rice have been experienced when grains get wet with the occurrence of sudden rains.

Farmers profess they cannot go to the farm from eleven o'clock in the morning until two o'clock in the afternoon due to the extreme temperature. According to them, the touch of sun rays to the skin at midday is painful and tingling, warranting the need to rearrange farm working hours. Consequently, it is very difficult to find workers who will diligently work for exactly eight hours in the farm due to the extreme temperature. "Nervz" (2018) confirmed "*There is really climate change. Because of the hot temperature, it is very difficult to find workers who will really work for an exact eight hours*."

> *Strong typhoons are now experienced in our place. If there is a typhoon, planted rice is affected. There is a decrease of yield. Thus, a negative no return on investment. We usually experience losses. Also, a wide area of agricultural area in this barangay turned into a part of the river ("Mat", farmer)*

> *"The climatic conditions we experienced and experienced in our locality include the increasingly hot temperature, drought, monsoon and typhoons that greatly affect the production of corn. In areas without irrigation, we cannot plant since we depend on rains for irrigating our crops. Drought during the seedling stage causes stunting of corn plants while the increasingly hot temperature during their flowering stage dries up the plants. Heavy rains also used to wash away the top soil and seeds which are newly sown. Rain also comes abruptly which makes the grain wet during drying activity. In recent years, typhoons Juan and Lawin have totally damaged our crops. We also observed that for a typhoon which lasts for a week, corn at harvestable stage*

can germinate while still at its stalk. Typhoons during the flowering stage will blow away the pollen grains and if there are survivors, some kernels will be unfilled. Typhoon also causes rotting of the harvested corn with the absence of the sun for drying. It is also during typhoons that transportation of products is difficult when roads are not accessible in some of the municipalities when water in the river rises. Landslides also occur in some areas during typhoons" several farmers confirmed.

Climate change has escalated the uncertainties in the region's agricultural production due to the increased occurrence, intensity, and length of rainfall events which consequently increase incidence of erosion, trigger landslides, and make certain crops susceptible to diseases. These occurrences have negatively affected crop production in the region, particularly during the crops' critical growth stages. The manifestations of climate change are now felt by many, especially by upland farmers whose agricultural production is vulnerable to the increasingly unpredictable weather conditions. Although the local communities in the Cordillera region have been able to maintain a sustainable relationship with the resources through their indigenous knowledge and practices, climate change has severely affected the region's agriculture sector (Sandoval & Baas, 2014).

Assessment of Climate Change Sensitivity

Climate Hazard Consequences. Cordillera farmers are confronted with the perennial threats to the productivity of their land resources posed by climate risks, particularly typhoons and drought. These hazards generally cause production and post-harvest losses in the farming industry. Typhoons have a major impact on the provision of seeds and other inputs while its impact on on-farm production is severe. Drought, on the other hand, has moderate to major severity on on-farm production.

The lowland rice farming systems in the Cordillera which depend on irrigation systems suffer losses when the supply of water decreases during prolonged drought. Lowland farm areas are also prone to flooding. On the other hand, corn production in the Cordilleras rely on rain for irrigation, thus, low production and poor quality of the kernels result when prolonged drought occurs. Corn production is also vulnerable to soil erosion and strong winds.

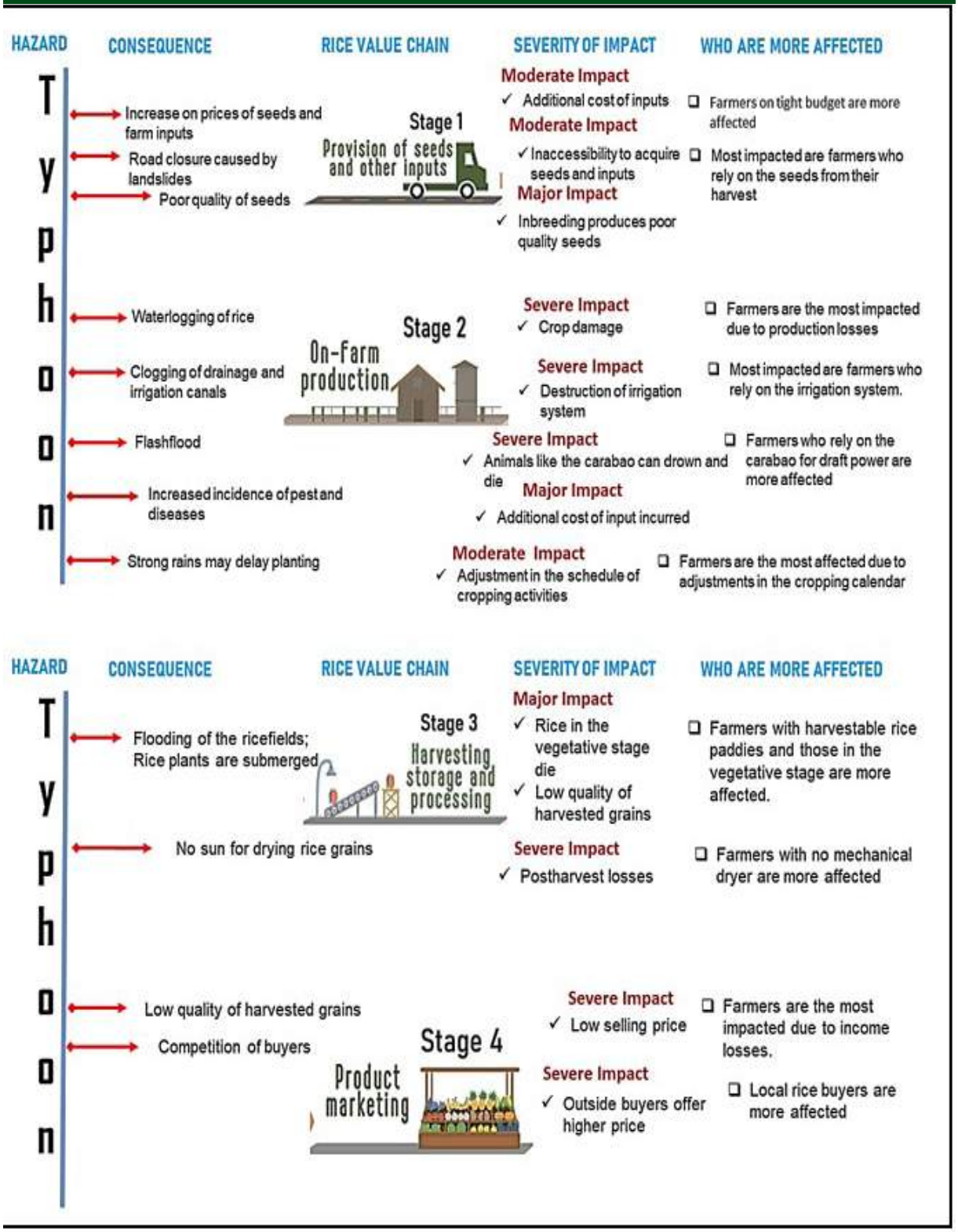
Strong winds during typhoons break or twist stems of crops which leads to major damages. Strong winds also disturb the growth and development of the crops, especially during the vegetative stage. Further, typhoons and drought severely increase the occurrence of pests and diseases. This adds costs for the farmers in buying pesticides and the need for additional labor as well. Aphids and stem borers attack corn plants affecting its maturity and making them unproductive. Formation of gullies is also observed in corn. On rice, pests include golden snails, hopper burns, worms, and rice bugs. Prolonged drought causes decreased water level in irrigation systems that curtails irrigation and makes the soil hard for tilling.

Corn is severely affected by excessive rainfall. Strong rains during typhoons cause soil erosion thereby reducing the vegetable production areas and carries away topsoil together with the nutrients resulting in decline in soil fertility. Farmers use herbicides and weedicides which loosens the topsoil, so it is easily carried away by surface runoff. The prices of rice and corn seeds and inputs increase moderately during typhoons. Rice and corn farmers also often experience major post-harvest losses with non-stop rains. Post-harvest losses are incurred by farmers since the majority of them rely on manual drying. Additionally, transportation of rice and corn during typhoons is difficult when the water level in the rivers rises (Giles et al., 2019).

Rice. Rice farmers usually plant seeds from their crop of inbred rice so if these are affected by typhoons, the quality is majorly deteriorated. While typhoons may supply the needed water during land preparation, they are dreaded since carabaos have been drowned in floods, resulting in less or total loss of draft power for ploughing and harrowing. Flooding caused by typhoons causes lodging of growing rice plants, from which only 35-40% survive and those that do bear low quality grains. Typhoons during the vegetative and flowering stages of rice can cause severe damages amounting to 50% or more of production loss (Figure 3). Damage on irrigation canals and waterways requires additional manpower and costs to fix the structures. Mature rice plants are likewise majorly affected by flooding caused by typhoons. Flooded rice results in low quality of grains and spoiling. Spoiling is incurred since

Figure 3

The Consequences and Impact of Typhoon to the Rice Value Chain.



there is a difficulty in finding manpower to immediately 'harvest the affected crops and drying is impossible during a typhoon. In the province of Abra, communities' experienced low supply of rice in the market in the aftermath of previous strong typhoons. This is exacerbated by inefficiency in the market regulatory framework where local produce is sold to outside buyers because they offer higher prices, leaving little or no supply for local consumers.

Drought, on the other hand, moderately affects rice farmers with the possibility of missing the next cropping especially farms with no access to an irrigation system. Missing one cropping season means no income for farmers (Figure 4). Lowland rice farming depends on irrigation which becomes scarce during prolonged drought (Giles et al., 2019).

Yellow Corn. Yellow corn production is vulnerable to soil erosion and strong winds during typhoons. Yellow corn growers in Paracelis, Mt. Province are moderately affected by typhoons if they occur just after planting. However, when a typhoon occurs during the flowering stage, it results in a major disruption in the pollination activity which results in incompletely filled or empty cobs during harvest. Typhoons that occur near harvest time may force the farmers to harvest early which results in some kernels not reaching the right physiological maturity, yielding low quality grains. Drying is likewise difficult when typhoons occur during harvest time (Figure 5).

Corn production in Cordillera relies on rain for irrigation, thus, low production and poor-quality grains are harvested when prolonged drought occurs (Figure 6). Prolonged drought also makes the soil hard to cultivate. Farmers incur major losses because many of the seeds they sow during drought period do not germinate and those that germinate hardly produce flowers. Farmers are also forced to shell out additional budget to dig deep wells and acquire water pump to draw out water for irrigation which is a major impact (Giles et al., 2019).

Figure 4

The Consequences and Impact of Drought to the Rice Value Chain.

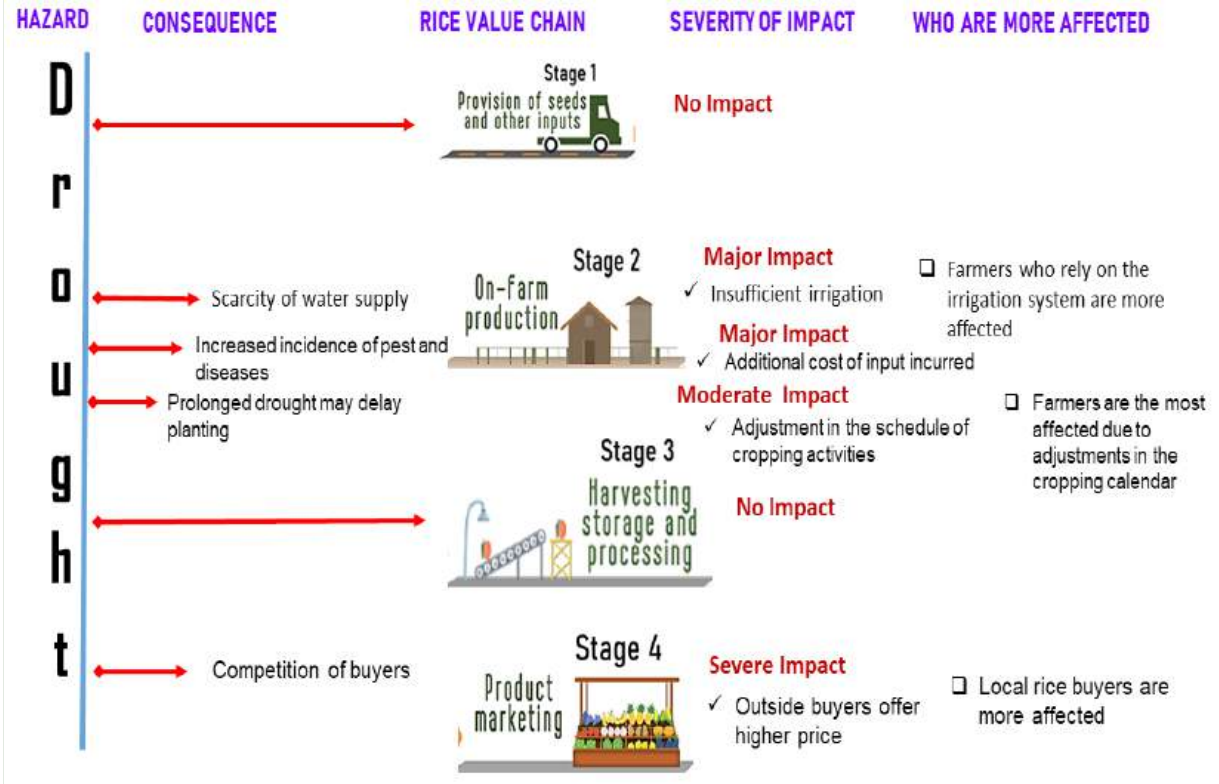


Figure 5

The Consequences and Impact of Typhoon to the Corn Value Chain.

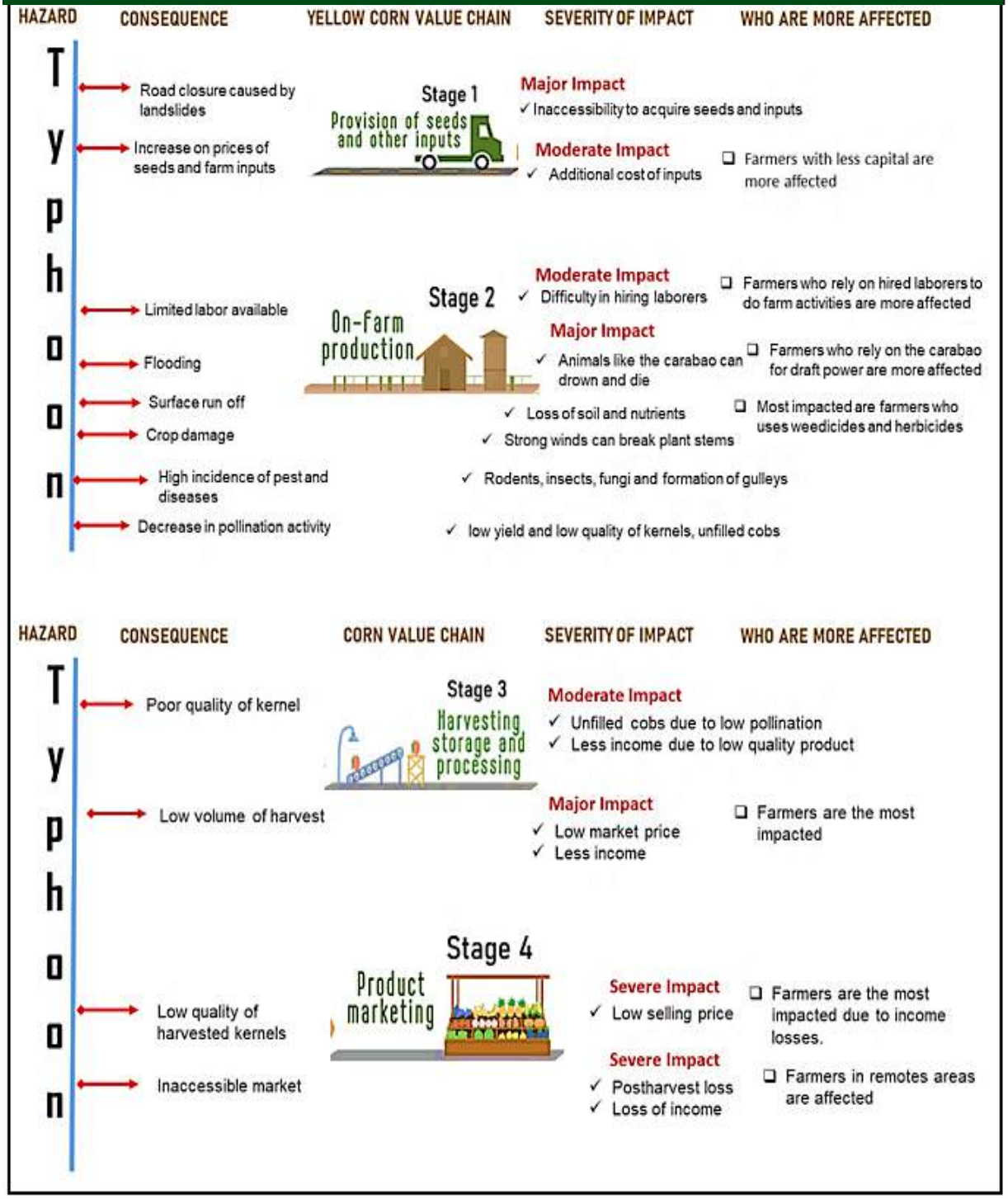
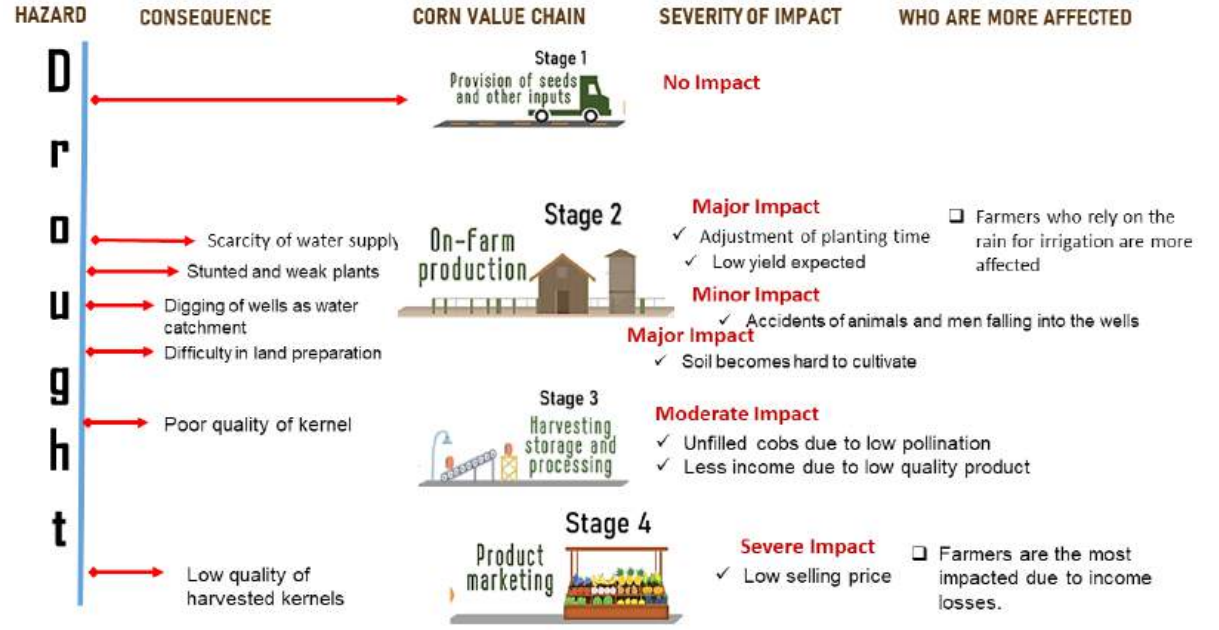


Figure 6

The Consequences and Impact of Drough to the Corn Value Chain.



Assessment and Identification of Adaptation Options and Prioritization

Rice Technological Farm Adaptation Practices. The use of high-yielding and early maturing varieties is an existing adaptation practice for rice farmers in the region. Using short-duration varieties allows farmers to have three cropping in a year (Giles et al., 2018). For some farmers, they use available drought-resistant varieties (Figures 7 and 8). According to them there are hybrid rice varieties which are drought resistant (Key Informant Interview, 2018). On the other hand, farmers in the region look forward to potential options particularly the development of typhoon and drought rice varieties.

Indigenous pest control practices of rice farmers in the Cordillera include the manual pick-up of golden snails locally called "Kohol" and by destroying their eggs. They scatter papaya leaves, trunks, and stems in the rice fields as attractive to the golden snails. The snails gather around the papaya plant parts during the night and the farmers pick them up in the morning to kill them by drying under the sun or pounding. Farmers observed a high population of golden snails during frequent typhoons and prolonged drought (Giles et al., 2018). In some areas where the 'Kohol' are too small and too many, farmers use botanical attractants such as sweet potato vines, papaya & banana leaves to control snails (Key Informant Interview 2).

The Integrated Farming System (IFS) is also an existing adaptation practice for rice and corn growers. The practice promotes the maximization of the land with the integration of livestock and several crops. These livestock and other crops serve as buffers from major production losses. Additionally, it ensures crop productivity and food security for the household. Rice farmers also establish small water impounding to secure water supply against drought.

One potential adaptation practice is the synchronized planting of rice by farmers. This is more effective if one variable is to be planted. Through this practice, pests and diseases which highly occur during typhoon and drought can be controlled, resulting to lesser damage. This practice reduces expenditure on inputs with reduced use of synthetic chemicals to control pests and disease thus provides healthy environment to the community. As for processing, corn and rice farmers identified the use mechanical dryers to cope with the non-stop rains during typhoons. However, the cost is a major barrier (Giles et al., 2018).

Figure 7

Adaptation Options and Underlying Vulnerability Factors to Typhoon of the Rice Value Chain.

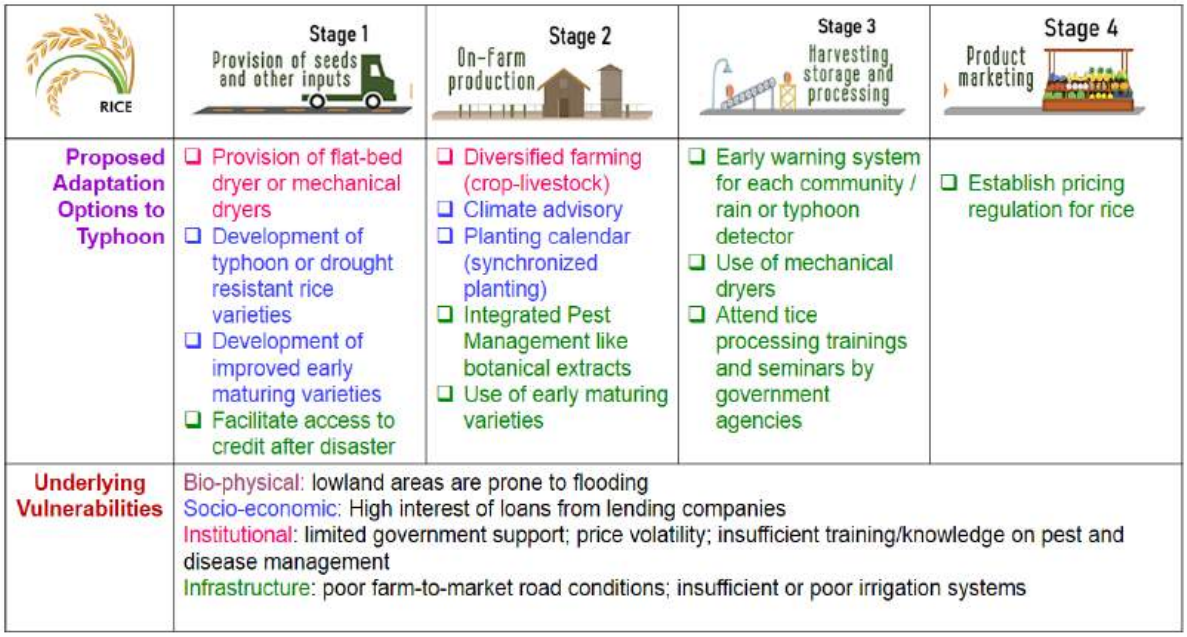
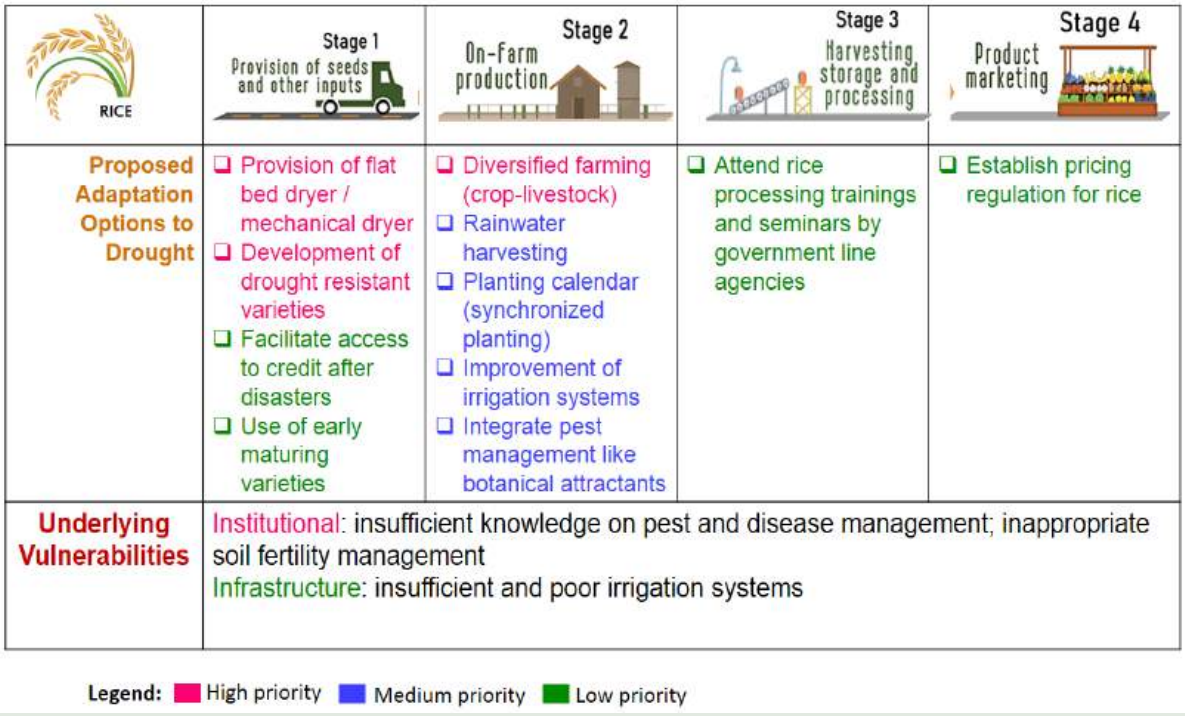


Figure 8

Adaptation Options and Underlying Vulnerability Factors to Drought of the Rice Value Chain.



Yellow Corn Technological Farm Adaptation Practices. Upland corn producers usually rely on rain for irrigation, although prolonged drought mobilizes them to cope up. Digging of deep wells to acquire water with the use of a water pump is a common strategy employed by farmers (Figures 9 and 10). For financially challenged farmers, the cost of adoption is the major constraint in adopting the practice. Hence, borrowing and/or hiring of water pumps from co-farmers is an initiative to access irrigation water. However, with the numerous dug wells, individuals including animals are predisposed to the danger of falling into the well, getting injured, drowning or even dying. Identified potential intervention for corn producers to cope up with drought is intercropping of corn with squash. The squash having broad leaves will serve as soil cover like mulch, decreasing the rate of water evaporation from the soil (Giles et al., 2018). Some farmers also build small water impounding facilities as catchment basin for rainwater during the rainy season (Key Informant Interview 3).

Some farmers identified some CRA practices introduced by the ATI-CAR together with the municipal and provincial agriculture office to corn growers like Sloping Agricultural Land Technology (SALT), Sustainable Corn Production in Sloping Areas (SCoPSA), and Good Agricultural Practice (GAP) for corn. SALT is a package technology on soil conservation and food production, integrating different soil conservation measures in just one setting. Basically, SALT is a method of growing field and permanent crops in 3-meter to 5-meter-wide bands between contoured rows of nitrogen fixing trees. The nitrogen fixing trees are thickly planted in double rows to make hedgerows. When a hedge is 1.5 to 2 meters tall, it is cut down to about 75 centimeters and the cuttings (tops) are placed in alley-ways to serve as organic fertilizers (Department of Science and Technology-Philippine Council for Agriculture, Aquatic and Natural Resources Research and Development [DOST-PCAARRD, 2018). Sustainable Corn Production in Sloping Areas (SCoPSA) is one of the Department of Agriculture's soil conservation and climate change adaptation measures for corn areas vulnerable to soil erosion in different locations of the country (Erondo, 2016). GAP on corn is simply applying good agricultural practices for safe and quality corn products while protecting the environment. Additionally, some farmers opt to employ manual weeding on their farm to avoid soil erosion. Scientifically, herbicides loosen the soil so it is easily washed out by heavy

Figure 9

Adaptation Option and Underlying Vulnerability Factors to typhoons of the Corn Value Chain.

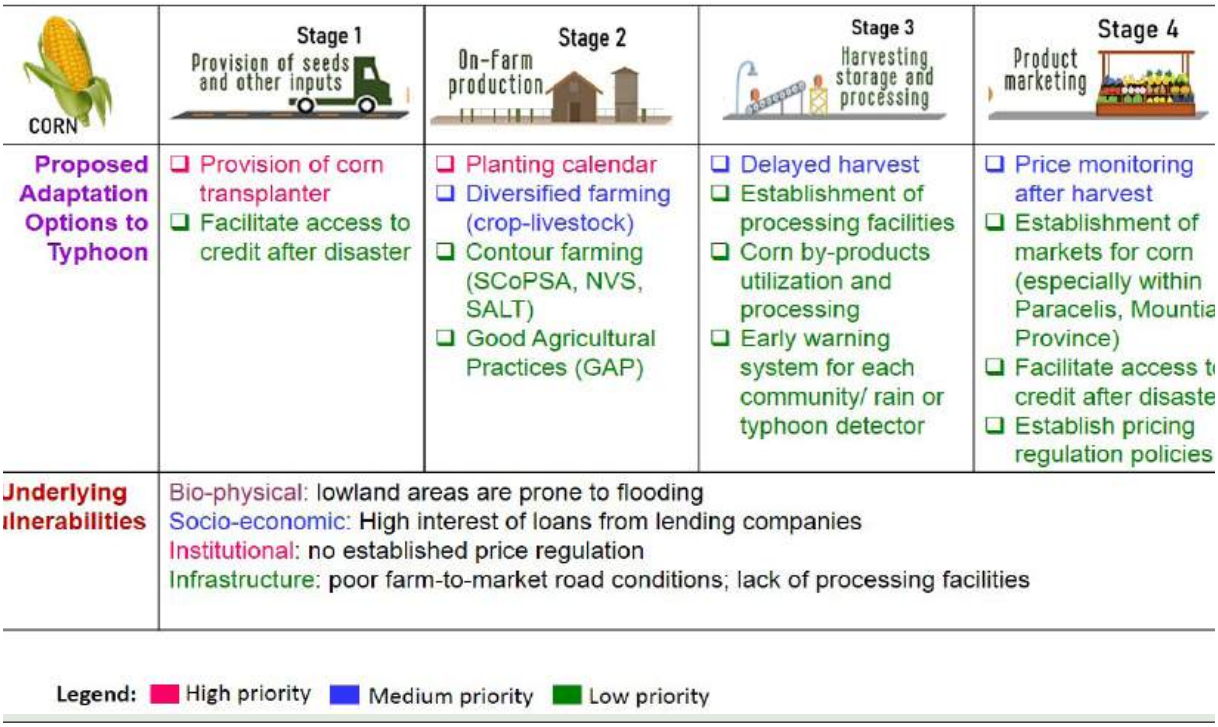
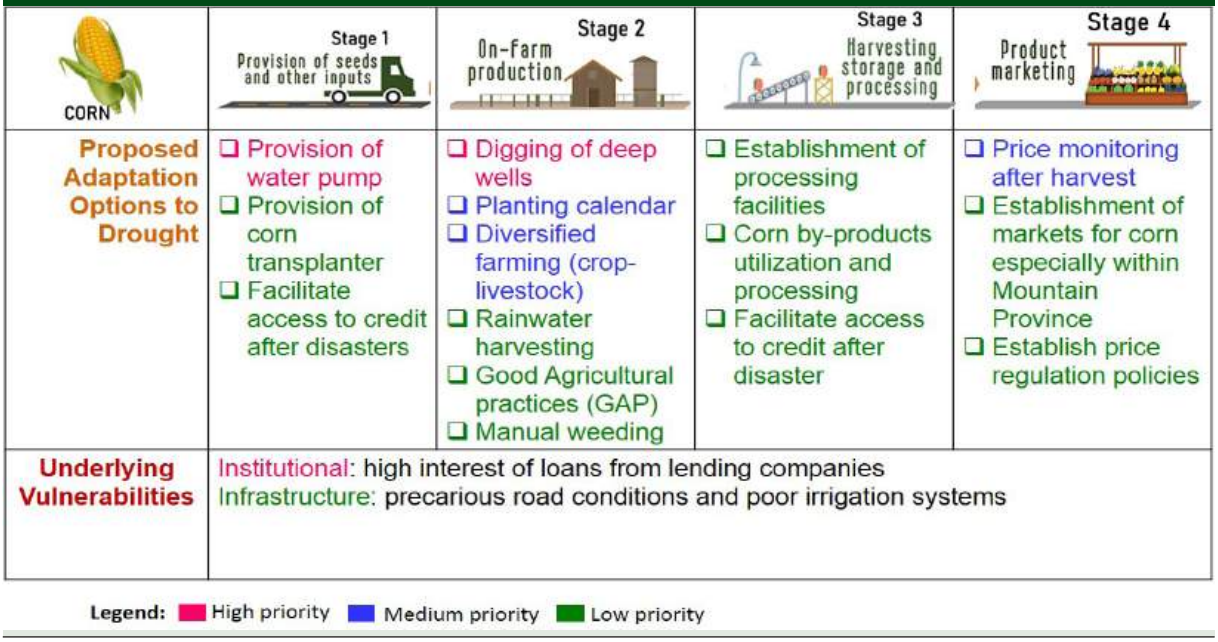


Figure 10

Adaptation Option and Underlying Vulnerability Factors to Drought of the Corn Value Chain.



rains during typhoons (Key Informant Interview 4).

Barriers to Adoption of Rice

In relation to climate hazards, rice farmers' ultimate barriers are the low awareness of climate smart techniques and the lack of climate information services. Farmers can only deduce that there is really a change in climate because they are experiencing major to total loss of production particularly during typhoons and drought. Farmers say they can do much remedy to reduce the impacts if only they are all empowered on the adverse effects of climate change. Common to other commodities is the barrier of lack of regulatory framework for market price. Accordingly, the National Food Authority (NFA) imports rice from other nations not because there is shortage of supply in the country but because farmers do not sell their products to them resulting in a lack of buffer stock. This is mainly because the offered price by NFA is lower compared to private buyers and the rigorous process required when selling rice to NFA.

Farmers urge the Department of Trading and Industry (DTI) and line agencies to establish appropriate price regulations. Another common barrier is the access to credit and financial support or assistance. Financial support or assistance is mostly needed after calamities like strong typhoons wherein the presence of the government must be felt during this time. The lack of technical capacity is also a barrier. Farmers claimed they have insufficient knowledge on plant pests and diseases and their management. This explains why they are dependent on using synthetic pesticides. As such, agricultural line agencies are recommended to conduct trainings and seminars on rice pests and disease management. In addition, they welcome the presence of Agricultural extension workers to provide them technical assistance (Figure 11).

Further, guidelines on the access to technical equipment are being questioned by some farmers who raised concerns that the end-users of the equipment provided are selected based on political affinity and not the marginalized ones. Government providers, on the other hand, identified issues of which distributed equipment were not being maintained and even went missing. To a greater extent, farmers were cautioned since some farmer association leaders use the name of the organization to avail of equipment from the government and use them for their own personal interest.

Figure 11

Barriers to Adoption of Climate Smart Technologies in Rice Production

RICE	BARRIERS		
VC STAGES Stage 1 Provision of seeds and other inputs	High cost of adoption; Limited access to credit; Long pay back periods	Lack of human capacity Lack of technical capacity No access to technical equipment	Climate change beliefs Conflict with traditional methods Short term goals
Stage 2 On-Farm production	High cost of adoption; Long pay back periods Limited access to credit Lack of human capacity	Lack of human capacity Lack of technical capacity No access to technical equipment	Climate change beliefs Conflict with traditional methods Short term goals
Stage 3 Harvesting storage and processing	High cost of adoption; Long pay back period Lack of financial benefits	No access to technical equipment Lack of technical capacity	Climate change beliefs Conflict with traditional methods Short term goals
Stage 4 Product marketing	Long pay back period Lack of financial benefits Limited access to credit	Lack of technical capacity Lack of human capacity No access to technical equipment	Climate change beliefs Conflict with traditional methods

RICE	BARRIERS	
VC STAGES Stage 1 Provision of seeds and other inputs	Lack of climate information services Low awareness of climate smart techniques	Low institutional support Lack of regulatory framework Weak linkages within government
Stage 2 On-Farm production	Low awareness of climate smart techniques Lack of climate information services	Low institutional support Lack of regulatory framework Weak linkages within government
Stage 3 Harvesting storage and processing	Low awareness of climate smart techniques Lack of climate information services	Low institutional support Lack of regulatory framework Weak linkages within government
Stage 4 Product marketing	Lack of climate information services Low awareness of climate smart techniques	Low institutional support Lack of regulatory framework Weak linkages within government

***Barriers to Adoption of Yellow* Corn**

Cordillera corn farmers experienced low institutional support. They appeal for initiatives like dispersal of quality seeds. Another barrier is the lack of technical equipment and facilities. These include the poor conditions of irrigation systems and farm-to-market roads which badly need upgrading. The cost of adoption is yet another barrier. They cannot afford to buy

machines such as water pumps, thus, they recommend the construction of water-impounding facilities. This lack of technical equipment affects a number of farmers. In the advent of modern farming technology, unfortunate farmers cannot afford to be mechanized. The farmers also recommended the construction of storage and processing facilities for farmers (Figure 12).

Further, there is low awareness of climate smart techniques among corn farmers which results in a low adaptive capacity to cope during climate hazards. There is also a lack of climate information services among farmers so they are unprepared during typhoons. In relation to product marketing, farmers pointed out the lack of regulatory framework, particularly on pricing of products.

Figure 12

Barriers to Adoption of CLimate Technologies in Corn Production

CORN	BARRIERS		
VC STAGES Stage 1 Provision of seeds and other inputs	Lack of financial benefits High cost of adoption	No access to technical equipment Lack of human capacity Lack of human capacity	Short term goals Climate change beliefs Conflict with traditional methods
Stage 2 On-Farm production	Lack of financial benefits High cost of production Limited access to credit	Lack of technical capacity Lack of human capacity	Conflicts with traditional methods Climate change beliefs
Stage 3 Harvesting storage and processing	Lack of financial benefits Limited access to credit	Lack of human capacity Lack of technical capacity	Short term goals Climate change beliefs
Stage 4 Product marketing	Limited access to credit High cost of adoption	Limited access to technical equipment Lack of technical capacity	Conflicts with traditional methods Climate change beliefs

CORN	BARRIERS	
VC STAGES Stage 1 Provision of seeds and other inputs	Low awareness of climate smart techniques Lack of climate information services	Low institutional support Lack of regulatory framework Weak linkages within the government
Stage 2 On-Farm production	Low awareness of climate smart techniques Lack of climate information services	Weak linkages within the government Lack of regulatory framework Low institutional support
Stage 3 Harvesting storage and processing	Low awareness of climate smart techniques Lack of climate information services	Low institutional support Weak linkages within the government Low institutional support
Stage 4 Product marketing	Lack of climate information services Low awareness of climate smart techniques	Weak linkages within the government Low institutional support Lack of regulatory framework

Climate Risk Profiles for a Climate-Resilient Agriculture on Potato and Cabbage Production in Benguet

An average yield of about 19 to 23 metric tons per hectare of cabbage was produced for the last ten years from 2008-2017. During the same period, 17 to 20 metric tons per hectare of potato was produced. In 2017, a total of over 11,000 hectares were utilized for cabbage and potato production (Office of the Provincial Agriculturist [OPAG], 2018).

Crop Farming System and Value Chain

Farming System. Monocropping with conventional crop management is being employed for 90% of cabbage and potato produced in Benguet. Farmers use synthetic chemicals to enhance soil fertility and control pests and diseases. Some farmers plant companion crops like onion leeks or radish on cabbage plots, for family consumption or incidental income. Majority of the farmers in Benguet follow crop rotation. They plant potatoes from January to February and harvest by June. After potatoes, they plant cabbage in July and harvest from October to November. Radish or carrot is planted as a third crop and will be harvested from December to January (Key Informant Interview, 2018).

Value Chain Activities. Cabbage and potato value chain activities follow the typical four stages.

Provision of Seeds and Other Inputs. Agricultural farm stores found in central towns mostly in Sayangan, Atok, Abatan, Buguias, La Trinidad, Benguet, and in Baguio City sell imported hybrid cabbage seeds to farmers. The popular and common cabbage varieties preferred by farmers include Scorpio, Lucky Ball, Ace Green, Gladiator and Rare Ball, among others. These stores also sell synthetic chemicals and synthetic fertilizers. One of the most prominent farm supplies in the province is the Sunrise Farm Supply located in La Trinidad. Planting materials for potato are available in some government agencies like the Benguet State University - Northern Philippine Rootcrops Training Center (BSU-NPRCRTC) in La Trinidad, Benguet, and the Bureau of Plant Industry - Baguio National Crop Research and Development Center (BPI-BNCRDC) in Guisad, Baguio City. Moreover, some private producers sell stem cutting to farmers. Seasoned farmers produce their own seeds by keeping the medium sizes from their harvest in storage for the next cropping season. Truckers parked along Caponga, Tublay, sell chicken dung as fertilizer to farmers. Some farmers with acidic soil also buy lime along the highway in Buguias, Benguet. Men are in charge of acquiring seeds and farm inputs, especially chicken dung because of the bulk and the need for hauling. It is common among farmers to purchase seeds and other inputs for the next cropping season after selling their products at the trading post (Giles et al., 2018).

A practice which sustains the farmers in the province is known as the "Pa-suplay system". In this system, the supplier provides all the farm inputs (land, seeds, fertilizer, and pesticide) to a farmer-cooperator who will take charge of labor to produce the crops. The total expenditures will be deducted from the gross income when the crop is harvested and sold. After which, the remaining revenue will be divided equally between the supplier and the farmer (Focus Group Disducssion, 2018).

On-farm Production. Cabbage and potato farmers perform the activities from planting to harvesting. Men are responsible in land preparation and in pest management while women are more involved in planting and weeding. The crops are irrigated with the use of sprinklers (Giles et al., 2018).

Harvesting, storage and processing. Men and women are involved in harvesting although men are more involved in hauling and transporting the produce. In Benguet, there are small-scale local processors of potato like the Rural Improvement Club (RIC) and Taynan Livelihood Farmer's Association (TLFA) which are both located in Atok, Benguet. TLFA has a minimum processing capacity of 30 kilograms per day. Their product is JJT Potato Chips weighed at 45 grams per pack and sold at a wholesale price of Php30.00 and a retail price of Php35.00. Their products are available at the Benguet State University Marketing Center in La Trinidad and during occasional agri-trade fairs. Women are mostly engaged in processing potatoes (Key Informant Interview, 2018). There are no processing technologies adopted for cabbage determined as of this study.

Product Marketing. The La Trinidad Vegetable Trading Post (LTVTP) is the center of marketing activities in Benguet province. It is where farmers bring their produce for sale to wholesalers and

retailers. Marketing for both potato and cabbage involves middlemen called disposers. These disposers are mostly women who negotiate for price with bulk buyers from Metro Manila, Pangasinan and other provinces. If the farmer is amenable to the price, the disposer adds a mark-up profit to the farmers' price then closes the deal with the buyer. These disposers also buy in bulk and sell to retailers who rent stalls within the trading post.

Sorters, packers and haulers can be hired on the spot in the trading post area. Sorters and packers are men and women while haulers are purely men who ferry packed products on their carts called "cariton" to the waiting trucks. The vegetables from Benguet are brought to Urdaneta in Pangasinan, and to the Balintawak and Divisoria markets in Metro Manila (Giles et al., 2019).

In 2015, the Benguet AgriPinoy Trading Center (BAPTC), a state-of-the-art trading facility was established in La Trinidad. This is a multi-stakeholder facility to directly link farmers to the market, thereby eliminating the disposers. Contrary to the LTVTP system, the farmers trading in BAPTC have control over the price of their products, thereby increasing their income. Figures 13 and 14 show the different value chain activities for cabbage and potato.

Assessment of Climate Hazard

The Climate Farmer's Perspectives on its Impact on Their Livelihood. Benguet was declared as the country's second most vulnerable area to climate hazards, based on its record of being frequently hit by typhoons and floods, according to the assessment study, "Hotspots! Mapping Climate Change Vulnerability in Southeast Asia" (Philippine Daily Inquirer, 2010). A study by Calora, Jr. et al. (2011) as cited by Malamug et al. (2017) showed that the province of Benguet is not free from the effects of climate change. Observed climate changes based on 1976 to 2009 records of the Philippine Atmospheric, Geophysical and Astronomical Services

Figure 13

Cabbage Production Value Chain Activities

Figure 14

Potato Production Value Chain Activities

Administration (PAGASA) Agro-meteorological station in La Trinidad are increase in temperature, warmer noon and colder afternoons, longer drought periods, and irregular rainfall, among others. The region is frequented by typhoons and these cause loss of human lives and significant damage to property and agriculture (PAGASA, 2015) as cited by Malamug et al. (2017).

Cabbage and potato farmers are confronted with perennial threats to the productivity of their land resources posed by climate risks, particularly typhoons and droughts. Typhoons have a major impact on the provision of seeds and other inputs. Strong rains during typhoons cause landslides resulting in road closure which severely hinders the mobility of goods and people. "Gero" observes "*The climate has changed. Now it rains almost every month and the weather gets extremely hot. For farmers like us, the right timing for planting is difficult to establish.*" "*With the effect of climate change, it is hard to determine the right timing for planting vegetables. It also results in low yield causing us to find alternative sources of income to augment the expenses of our family,*" Fred added.

Another farmer intoned "*Heavy rains and hailstorms damage our crops. Rain and hail storms at present are heavy and extreme. The weather nowadays is unpredictable, which makes choosing what crop to plant a challenge.*" "*Climate change increases clubroots disease and leafminer pests. Farmers then continuously spray chemicals,*" remarked Jakie". This was seconded by "Art" who said, "*Insect pests and plant diseases are increasing and emerging. It results in low productivity/yield.*"

During the drought, "Rod" reported "*The weather became warmer. The climate pattern has changed. Typhoons nowadays are stronger compared to before. With these impacts, the right timing for planting is difficult to establish.*" "Andy" approves saying "*Sources of water in the farm are drying up so crops*

which are not irrigated produce a lower yield." Other perceptions from farmers are the following:

> *"There are a lot of impacts of climate change in our livelihood. The climate pattern has changed so we could not just plant the vegetables we want. Selection of what vegetable to plant is a challenge due to climate patterns. We cannot also apply the timing of planting we are used to. The rain at present is also heavy, which destroys our planet. The heat of the sun is extremely hot which easily dries the soil so it needs to be watered regularly. Due to the extreme heat of the sun, we cannot go to the farm from 11:00 AM to 2:00 PM".*

> *"Old practices like crop rotation cannot be applied by some farmers due to climate change. The months for rain and dry season had changed so the right timing for planting is difficult to predict. Climate change has really affected the livelihood of farmers. If a typhoon comes, there will be more expenses and less income".*

> *"I do not know what kind of seedling to plant due to climate change. Expenses on farm inputs are likely to increase during typhoons. You will also need more insecticides and fungicides. So, during typhoons, more expenses and less income are experienced".*

> *"I used to plant potato and cabbage before. I experienced selling our produce at low prices and I think this is an impact of climate change. It cannot support the needs of my family which prompted me to shift to cutflowers. We harvest every week and still earn low income but at least it can provide our needs. I still plant potato and cabbage in a small area".*

Farmers cannot purchase inputs when roads are closed. Meanwhile, the impact on the on-farm production is severe especially when it occurs during land preparation. Work in the farm is suspended throughout a typhoon and when land preparation is delayed, a major adjustment in all the succeeding activities and the cropping calendar happens. Typhoons increase the risk of accidents for farmers during harvesting and transporting. Road cuts may lead to a reduction or total loss of income for farmers who cannot deliver their produce in time to fetch a good price at the trading post.

In the aftermath of Typhoon Pepeng in 2009, some Benguet farmers recalled that they took alternative routes as far as the Ilocos region just to bring their products to LVTP because of severe road cuts along the Halsema Highway. Some farmers opt to harvest even during typhoons especially crucifers like cabbage if they are at their maturity stage because they will rot and crack when not harvested. In a positive light, there is low supply and high demand for vegetables on the market during typhoons so prices are likely to increase. Drought, on the other extreme, results in cabbage producing small heads (CIAT, 2018).

Local processors of potatoes in Atok, Benguet are also severely affected by typhoons. The occurrence of thick fog freezes the cooking oil and raw potato, requiring longer heating and frying time. Condiments such as frying and cheese powder become moist and lumpy. The worst impact of processing potatoes is the reduction of crispness (Key Informant Interview, 2018).

Assessment of Climate Change Sensitivity

The province of Benguet is more prone to landslides, soil erosion, and strong winds due to typhoons. This is attributed to its geographical location which is characterized by sloping terrain and deep valleys. Strong typhoons cause landslides which result in road closure of farm-to-market roads. This is a severe impact that delays farmers in the acquisition of seeds and other inputs across the four commodities. A strong typhoon has a major impact on the supply-demand of the four commodities in the market. There is often a low supply of products available in the market since landslides and floods along the roads caused by heavy rains during typhoons impede farmers from transporting their produce. The domino effect would be the increase in prices of products.

The result of the assessment corroborates with previous findings that the climate change hazards most frequently experienced are typhoons, strong winds, monsoon rains, dry spells, frost, and hailstone (Laurean et al., 2017).

Climate Hazard Consequences

Cabbage. Typhoons and droughts have a major to severe impact on cabbage production across the different stages of the value chain. Strong rains

cause landslides in erosion-prone areas, resulting in road closures of small farm-to-market roads and major highways in the province (Figures 15 and 16). Delivery and purchase of inputs are delayed and those who are from the center towns or markets are severely affected. Additionally, erosions on farmlands carry away topsoil together with the nutrients resulting in a decline in soil fertility and causing a reduction of arable production area which is considered a severe impact. Excessive rainfall during typhoons leads to soil erosion thereby reducing the cabbage production areas. Strong rains during typhoons can uproot or wash away cabbage seedlings, causing a major loss to farmers. An increase in insect pests and plant fungal diseases is observed after a period of long rain, prompting farmers to increase the frequency of insecticide and fungicide application, adding to the already high cost of production and all the more straining the farmer's budget. Cabbage diseases during prolonged rains include rotting, blight, black leg, and leaf spot.

Organic farmers who use cultural practices to manage pests are likewise burdened by the labor required. When typhoons occur at the crops' stage of maturity, some farmers opt to harvest despite the strong rain and wind since most of the time, prices of vegetables increase due to low supply. However, this exposes the framers, especially men, to health and accident risks. They may get sick and it is not safe to travel because of road cuts and falling rocks during landslides. Delay in transportation is also expected.

Drought, on the other hand, has no impact on the provision of inputs, and harvesting, storage, and processing but can severely affect on-farm production and marketing of products. Lack of irrigation water especially during the heading stage results in small heads and consequently lower prices in the market. Farmers whose farms are rain-fed, not covered by the government's irrigation projects, and do not have water-impounding facilities are most affected.

Potatoes. The same consequences are observed in the potato value chain (Figures 17 and 18). Erosions and road closures cause delays in the purchase of needed inputs. These are also major causes of postharvest loss when the transport of produce is delayed or impossible. Potatoes are severely affected by excessive rainfall during typhoons. This leads to soil erosion which carries away topsoil together with the nutrients resulting in a decline in soil fertility and reducing the vegetable production areas.

Severe crop damage can be incurred when typhoons occur during the vegetative stage of potatoes which ultimately results in low yield. Rotting, blight, and black leg are aggravated

Figure 15

The Impact of Typhoons on the Cabbage Value Chain

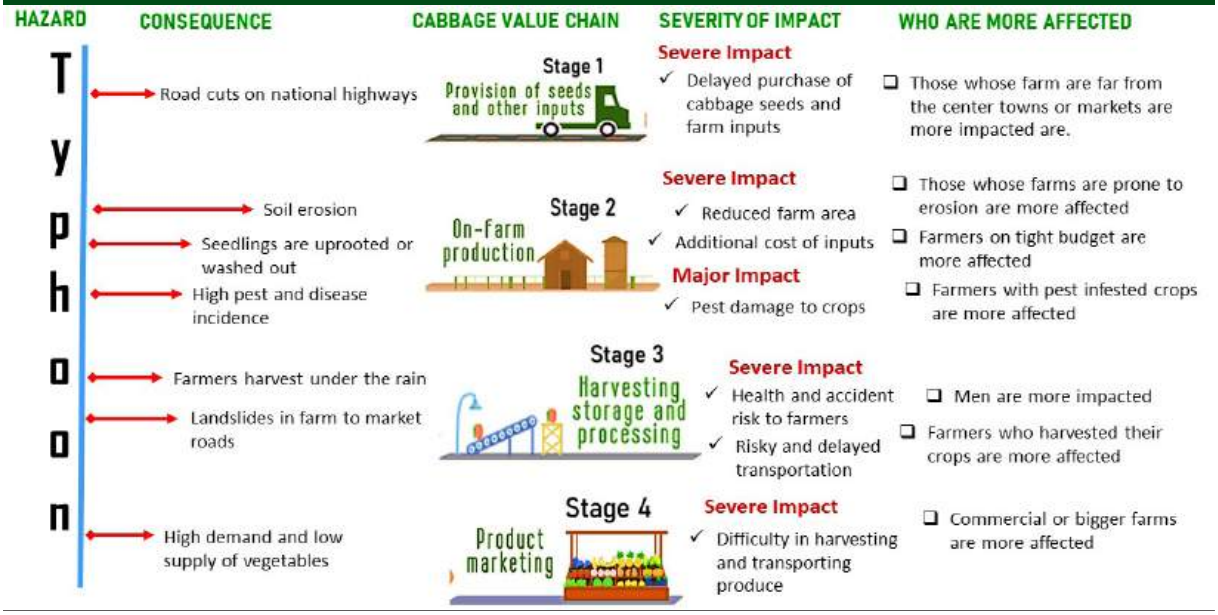


Figure 16

The Impact of Drought on the Cabbage Value Chain

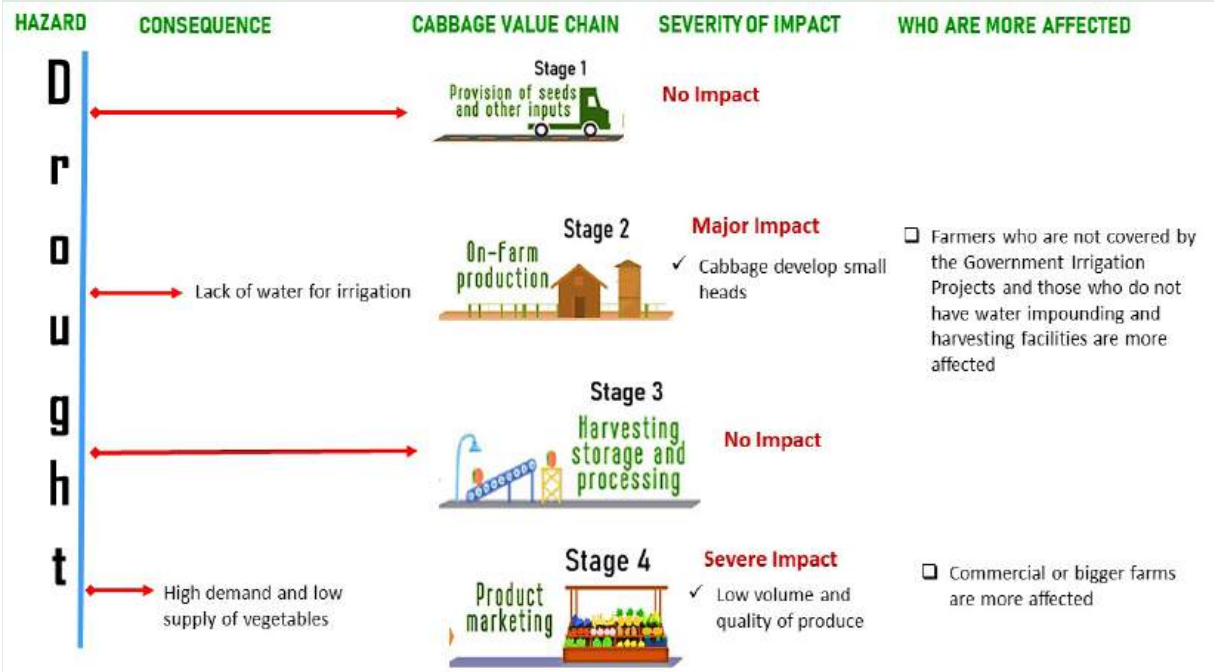
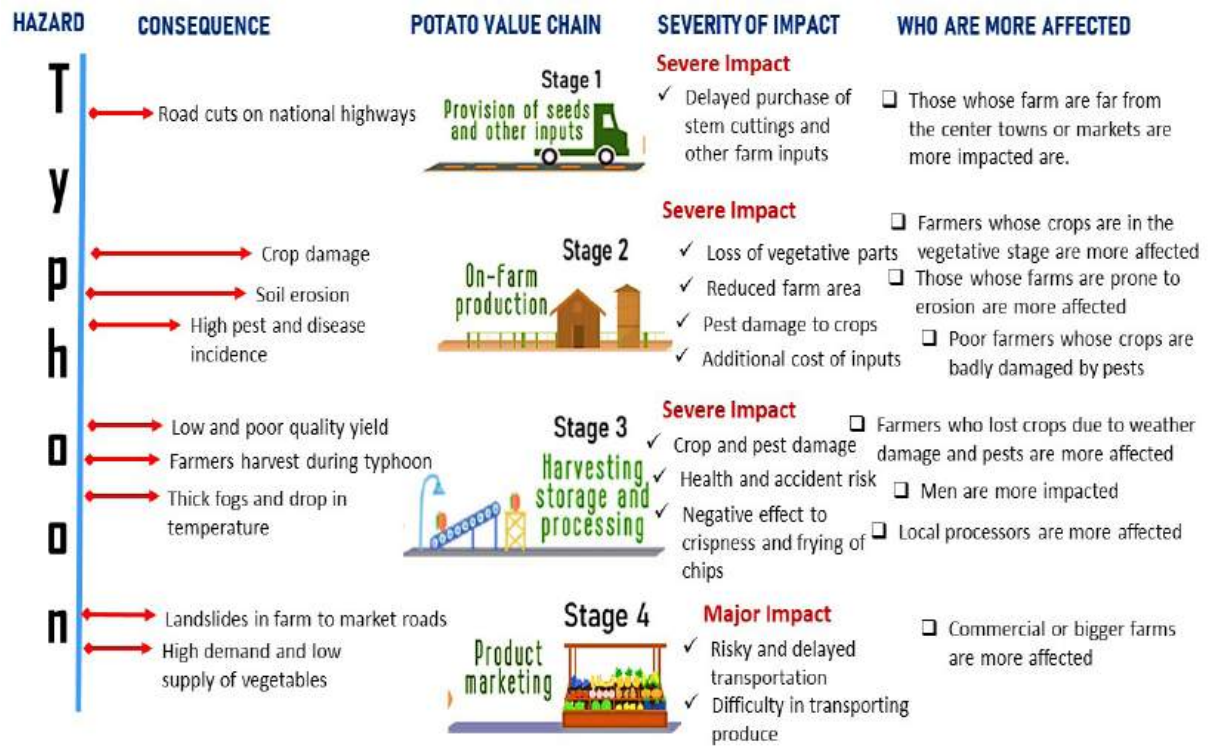


Figure 17

The Impact of Typhoons on the Potato Value Chain



during prolonged rains, requiring additional costs for mitigation. All these consequently redounds to loss of income for farmers. Potatoes exposed to drought become stunted and eventually yield a few tubers. A low volume of production eventually results in a limited volume of potatoes for processing. Since processing is not the main outlet for harvesting potatoes, a drop in production would affect their operations.

Earlier studies are consistent with current findings that hazards such as typhoons and monsoon rain cause the rotting of crops, breaking of stems and twigs, or total lodging of plants and falling of fruit trees. Damages to vegetable crops due to typhoons range from 80% to 100% because most plants need to be replaced (Fagyan, 2017). The dry spell causes an increase in the number of plant pests and diseases. It also leads to yellowing or blackening of leaves, stunted growth, and smaller size of plants. Excessive rainfall leads to the destruction of vegetable terraces, thereby reducing the vegetable production areas and carrying away topsoil together with the nutrients resulting in a decline in soil fertility. It could also lead to flooding and landslides which damage low-lying production areas, hence, increasing disaster (Laurean et al., 2017).

Further, strong winds, break or twist stems of plants that will cause black leg disease and uproot the plants which lead to less production of vegetables (Gapasin et al., 2014) as cited by Laurean et al. (2017). It could lead to as much as 50% damage on highland vegetables. The farming community faces economic impacts like costly repair of terraces due to the expensive cost of rock materials for riprapping; lower yield and crop quality resulting in reduced farm revenues; increased cost of inputs in pest management as an effort to increase yield and crop quality; and for some farmers, continues cropping is increasingly not possible due to lack of irrigation water during the dry season. The reduced income leads to the demand for supplementary off-farm employment for men and women (Laurean et al., 2017).

Underlying Vulnerability Factors Affecting Proposed Adaptation Options

The adaptation of interventions to mitigate the effects of typhoons is inherently affected by underlying vulnerability factors in different realms such as biophysical, socio-economic, infrastructure, and institutional, among others

Figure 18

The Impact of Drought on the Potato Value Chain

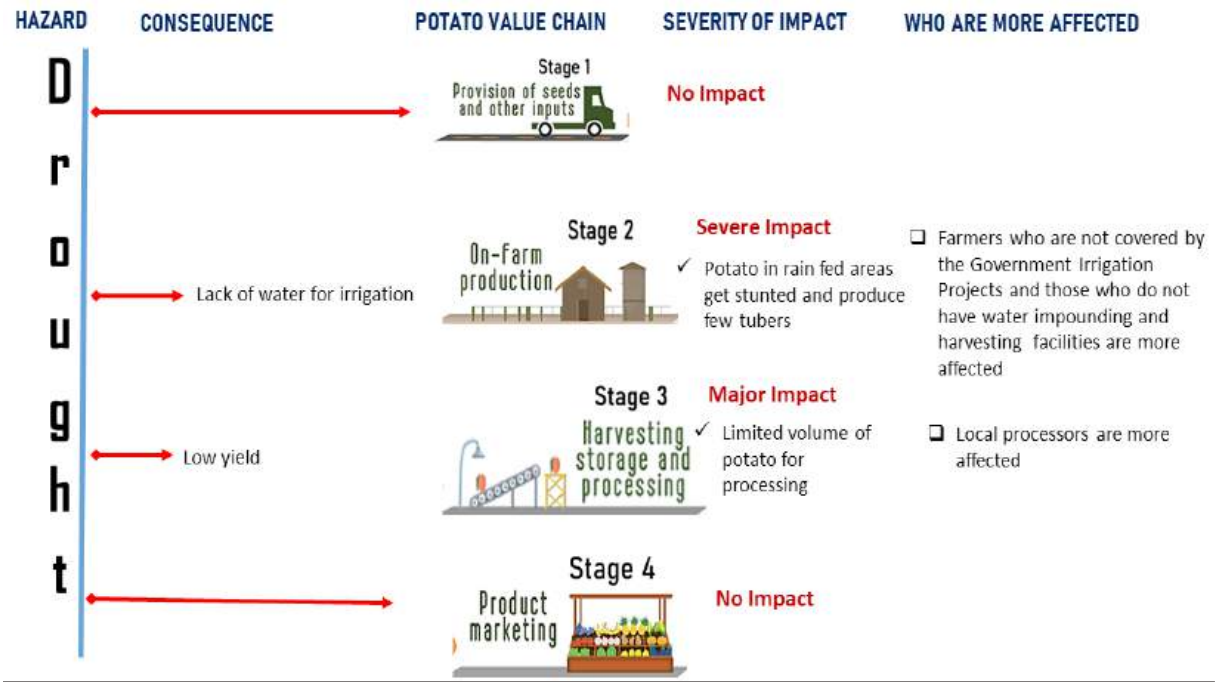
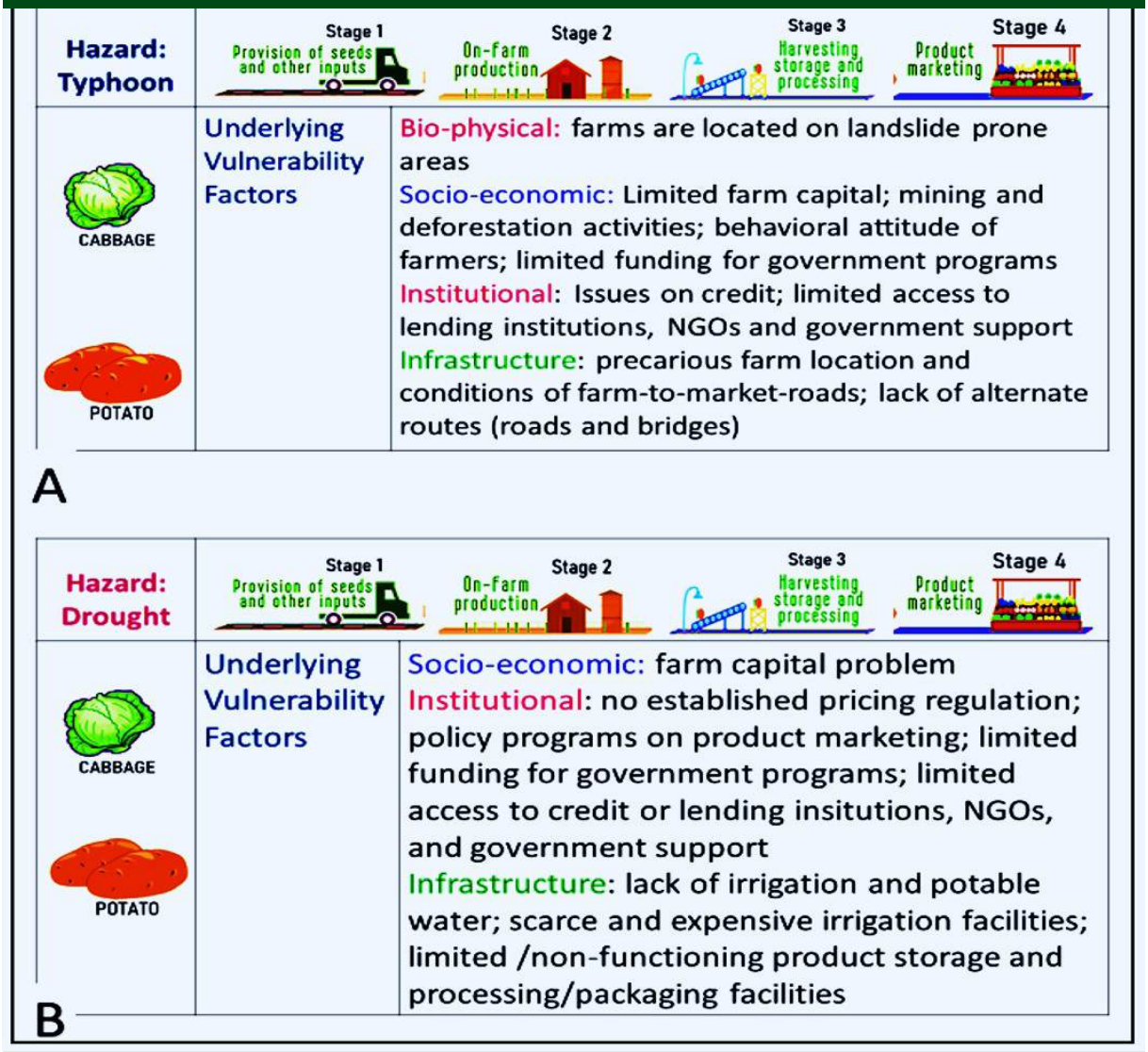


Figure 19

Underlying Vulnerability Factors to Climate Hazards in the Cabbage and Potato Value Chains A) Typhoon; B) Drought



(Figure 19). Most cabbage and potato farms in Benguet are located in high-elevation areas that are prone to landslide or erosion during typhoons which is a biophysical hindrance. All value chain actors are affected by this situation. Most farm-to-market roads in remote areas are not cemented and are in bad shape and the most vulnerable are the farmers. In addition, the implementation of policy programs which depends highly on political will affects all stages of the values chain. Policies may need to be improved for inclusivity and transparency and need to be disseminated and implemented in the best interest of all stakeholders.

Capital is the main vulnerability factor affecting on-farm production. Not all farmers are members of farmers' organizations so they are not qualified to avail of some government lending programs. Some credit and lending institutions require a lot of requirements to avail which takes time to process or farmers do not have. More importantly, the high interest rates for certain loans are a hindrance, especially to small farmers.

Mining activities and deforestation predispose communities to landslides and soil erosion. Farmers in the municipalities of Itogon, Mankayan, Tublay, Atok, and Bakun are subject to these

vulnerability factors. These activities likewise aggravate the dwindling supply of irrigation and potable water over time. Concerning drought, not all farms are covered by irrigation programs of the government, and not all farmers can afford to construct or acquire irrigation facilities like water impounding dams or water harvester tanks. On the socio-economic side, some farmers have limited access or don't have information on how to seek assistance from government agencies or NGOs. Farmers often do not have time to go to government offices to inquire about available agricultural programs. Some farmers are not interested in attending seminars and trainings being conducted by concerned government agencies. The government is introducing Good Agricultural Practices (GAP) and organic ways of farming and conventional farmers who do not stay updated may be more vulnerable. Hesitance to adopt mature agricultural technologies, lack of cooperation among farmers, and their short-term goals are other sociocultural factors worthy of consideration. Poor dissemination of government programs is mainly due to the limited number of Agriculture Extension Workers (AEW). Some of the government-implemented programs of the government are not being sustained due to limited funding and poor monitoring. Moreover, there is a lack of marketing facilities in the province. At present, there are only two functional trading outlets. Marketing of products is largely done at the La Trinidad Vegetable Trading Post where prices of commercial vegetables vary from time to time. Farmers are almost always in a gambling position given the fact that there is no established pricing regulation and imported vegetables are free to enter the Philippine market.

Assessment and Identification of Adaptation Options and Prioritization

Too much rainfall due to typhoons compels the farmers to increase the frequency of spraying fungicides for diseases such as blight on potatoes and leaf spots on cabbage. More conservative farmers plant Igorota, a blight-resistant potato variety during the rainy season. Farmers are aware of the benefits of planting hedgerows such as calla lilies in the farm borders as a coping mechanism against strong winds. However, few of them are employing this technique since they perceive that strong winds are hard to control. Figure 20 shows the adaptation options for typhoons prioritized by the stakeholders in 2018.

Potential adaptation options for potatoes include the establishment of a nursery for potato tubers, diffuse light storage, and a seed bank. Farmers suggested every barangay have a nursery for tubers and diffuse light storage for potato tuber planting materials. In 1983, DA-HADP established 56 units of diffuse light storage houses with 10 MT, 20 MT, and 50 MT capacity for identified beneficiary associations and cooperatives in Buguias and Atok, Benguet. These were established to provide seed storage for the next cropping season and reduce the importation of seeds. Most farmers are using these storage houses but need to be upgraded (Gonzales, & Kiswa, 2016). In addition, farmers recommend the establishment of seed banks to conserve and minimize the loss of adapted local varieties.

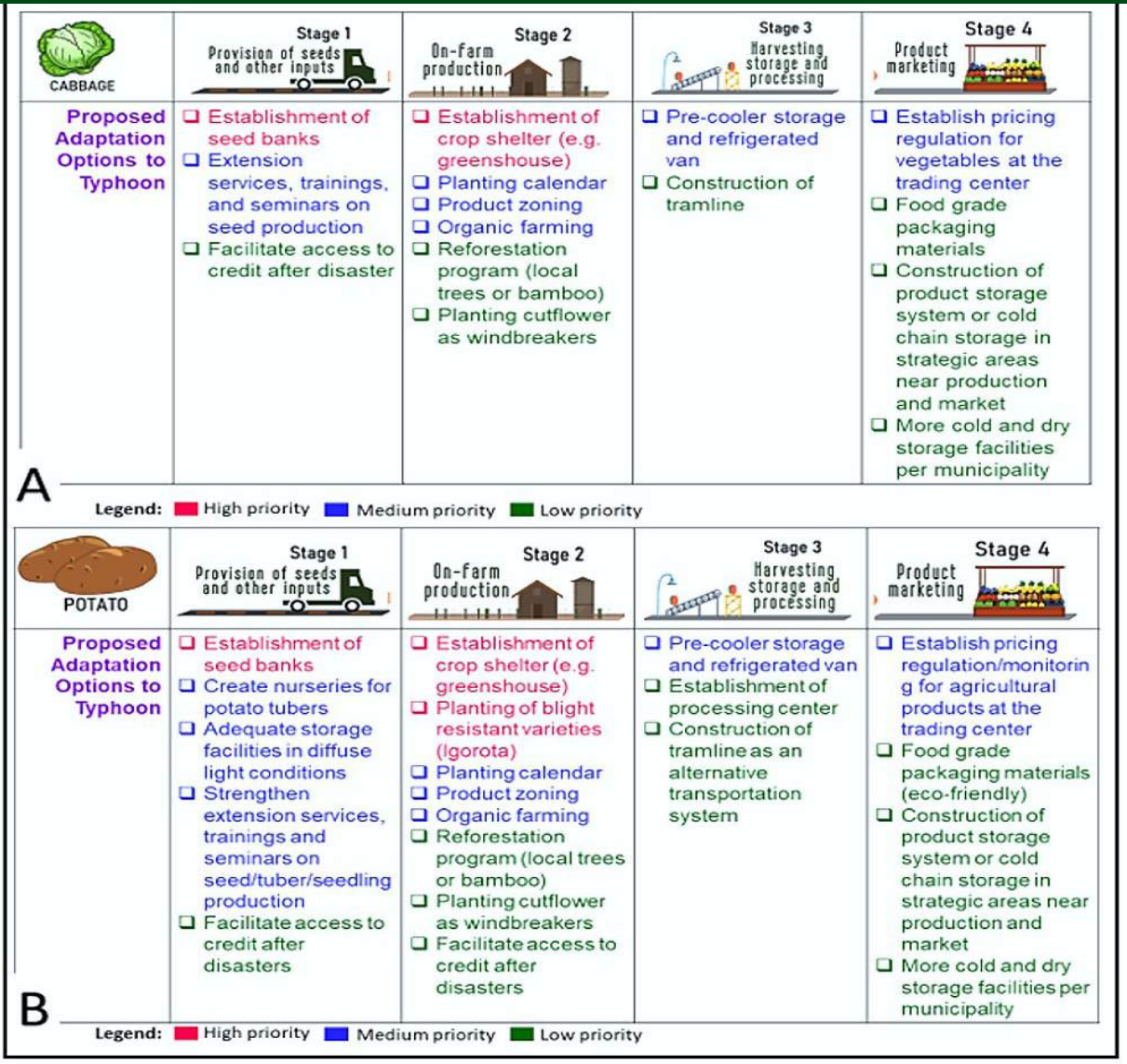
Farmers are also encouraged to acquire recommended quality seeds. According to academic researchers, the major source of clean and quality seeds for potatoes is from government research development centers. Farmers also suggested trainings on potato tuber seedling production. BSU-NPRCRTC with support from line agencies and LGUs is conducting trainings for potato farmers on production quality seed tubers through rapid multiplication of recommended potato varieties.

Another existing and potential adaptation option is the establishment of crop shelters such as greenhouses to avoid waterlogging and damage to crops during typhoons. It serves as a protective structure against strong winds and helps to control plant pests and diseases. Some farmers employ tunnels made of plastic to prevent moisture from entering. However, this practice is seldom done because of the lack of materials to cover the entire farm especially if the farm is wide. Besides, the cost of adoption is a major hindrance to farmers.

Organic farming is yet another adaptation and mitigating technology to the adverse effects of climate change. Per the record, the DA in 2015 reported a total of close to over 43,000 organic farming practitioners in the country from an initial number of almost 8,000 in 2011 (Catajan, 2016). Data gathered by the Cordillera Organic Agriculture Research and Development Center

Figure 20

Adaptation Options to Overcome Typhoon Hazard to the Value Chain: A) CAbbage; B) Potato



(COARDC, 2017) of BSU shows a total of 50 farmers' organizations devoted to organic agriculture in Benguet province. Data also shows a total of 3,326 individual organic practitioners in the province. Reforestation such as planting trees like bamboo is yet another sensible mitigating option to restore the denuded mountains, generate water, and prevent landslides.

The establishment of cold and dry storage facilities on-farm and on the market to preserve the freshness of the products and to prolong shelf-life was mentioned by the farmers. They further suggested the use of food-grade packaging materials to maintain the quality of vegetable products. According to BAPTC Chief of Operations Officer Dr. Violeta Salda (2018), one of the major reasons why the importation of vegetables is welcome is because Benguet vegetables do not meet international quality standards (CIAT, 2018).

The establishment of a processing center with complete facilities managed by a farmers' organization with financial support from the government was identified as a potential adaptation option (CIAT, 2018). However,

according to some of the local vegetable processors, one of the primary requirements to avail of assistance for such is a detailed proposal which farmers do not have the technical knowledge to prepare (Key Informant Interview, 2018).

Some stakeholders call for the policy makers in the province to craft and strictly implement pricing regulation guidelines for vegetables at the trading center. Prices of commercial vegetables in LTVTP are largely controlled by middlemen and change by the day or by the hour. Farmers are always in a gambling situation given the fact that they have weak bargaining power over the prices of their produce. Hence there is no assurance of a good price for farmers every time they deliver their products (CIAT, 2018).

For drought, farmers requested the development of cabbage drought-resistant varieties (CIAT, 2018). Based on the review, Tad-awan and Shagol (2016) recommend Lucky Ball and Ace Green varieties for drought conditions. The onset of drought necessitates frequent irrigation especially if ambient temperature is high. Farmers with access to water resources and those who have water harvesting tanks use sprinklers or rain bursts to water their crops. Farmers with financial capacity construct on-site water harvesting tanks to collect rainwater during the rainy months. This makes cropping possible throughout the drought season. Unfortunately, the cost of adoption is a major barrier to some farmers who would like to adopt the technology. Resourceful farmers with limited capital improvise by digging large holes and lining them with large plastic sheets or using tarpaulins to act as water catchments. Figure 21 displays the proposed adaptation for drought in the cabbage and potato Value Chains.

The study of Laurean et al. (2017) further recorded other existing adaptation strategies being employed by farmers. Farmers spray pesticides frequently to lessen the damage caused by pests and diseases. The practice of some farmers is to start with a green-labeled chemical and then shift to red-labeled chemicals if pests and diseases are not controlled. Another remedy is the practice of intercropping repellent crops which help ward off the populations aside from source of additional income.

The implementers of said adaptation are the conventional farmers, organic farming practitioners, the community, and Farmer's Associations. Technical assistance comes from government line agencies such as the Department of Agriculture (DA-CAR, BPI, OPAG, OMAG), Philippine Center for Postharvest Development and Mechanization (PHilMech), Department of Environment and Natural Resources, the concerned Local Government Units (BLGU, MLGU, PLGU) and policymakers, State Universities and Colleges (SUCs), government and academic researchers (BSU-NPRCRTC) and extension workers. Non-government Organizations (NGOs) may also play important roles in the implementation of these mitigation measures. Financial assistance is extended by the Agricultural Credit Policy Council (ACPC), banks, and various cooperatives.

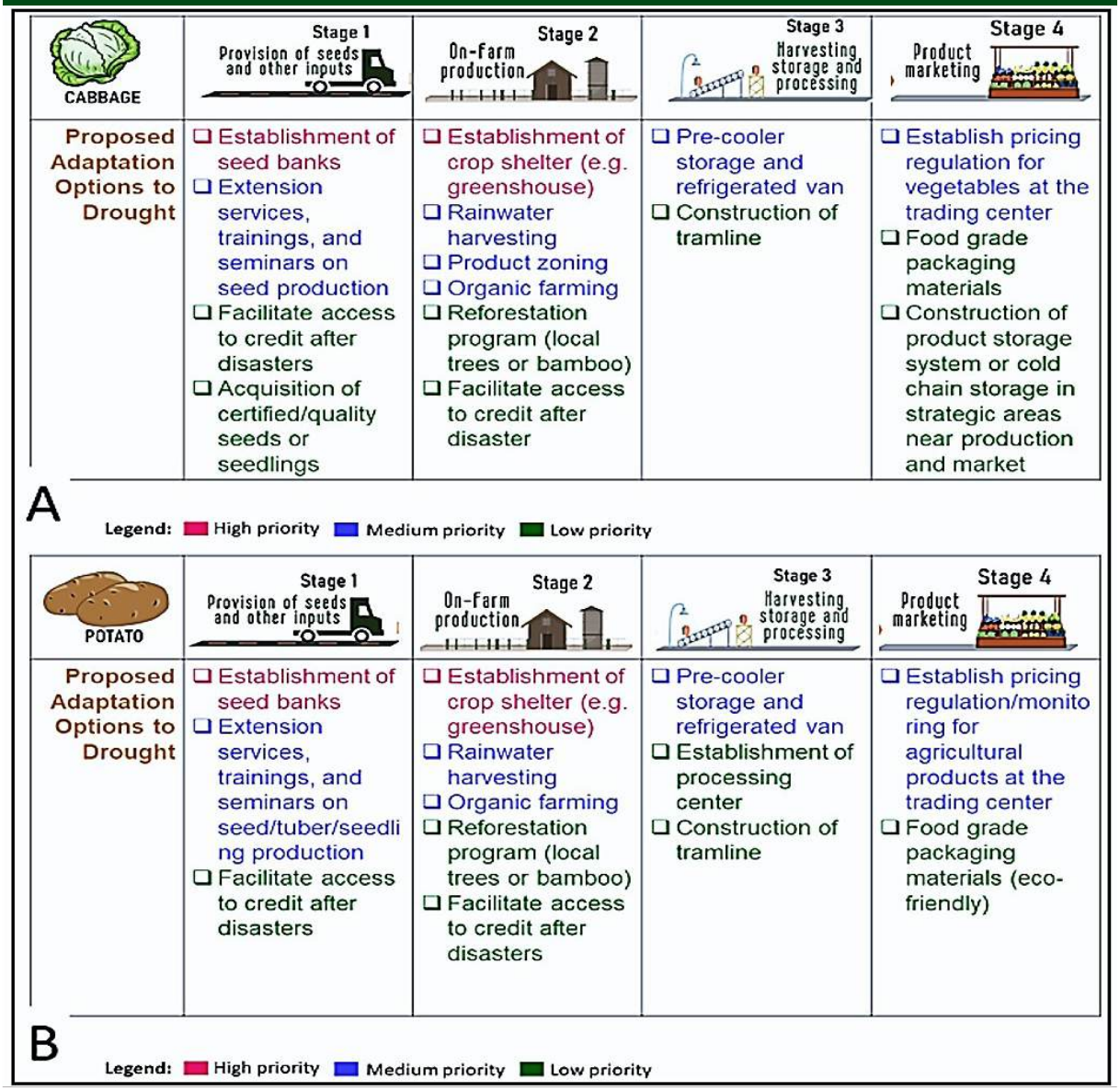
Barriers to Adoption. The barriers that deter farmers from adapting the proposed mitigating measures are classified into financial, technical, behavioral, informational, and institutional (Figure 22). A major financial hurdle in adopting climate-smart technologies is the cost and access to the technology. Many farmers cannot afford to establish greenhouses, water harvesters, and the like due to limited capital. Farmers appeal to the Department of Agriculture to distribute or provide accessible equipment like hand tractors, shredders, power sprayers, and other needed equipment to indigent farmers (CIAT, 2018).

Some farmers are not members of any association so it is difficult for them to access credit or government subsidies and programs. Farmers then have to recognize the advantages of being a member and the need to support the association. On the other hand, long pay back periods and lack of financial benefits discourage farmers from availing loans. With limited access to credit, farmers are stuck with the "pa-supply system" which mostly benefits the financier. Farmers clamor for more credit access and financial support from the government with less documentary requirements most especially after strong typhoons which usually leave severe damages.

Furthermore, technical roadblocks identified include a lack of technical capacity, no access to technical equipment, and lack of human capacity. There is a need to upgrade the technical skills and knowledge of farmers for them to be able to cope with the changing times. For instance,

Figure 21

Adaptation Options to Overcome Drought Hazard to the Value Chain: A) Cabbage; B) Potato



quality seed production technologies are highly technical. Mechanization should also be introduced and technical equipment be made accessible to farmers at affordable terms. Human capacity is a critical barrier as it was reported by Integrated Regional Information Networks (IRIN) in 2013 that the Philippines might reach a critical shortage of farmers in just 15 years because they are already aging – 57 years old on average.

In terms of behavior, it was observed that farmers' goals and objectives are for the short term. Most farmers just focus on how to survive the present, taking each day at a time. Some are content with traditional farming methods and therefore not interested in adopting new technologies. Still, it is a call for all concerned offices to continuously educate farmers through trainings and seminars. It is also recommended that farmers acknowledge the essence of sustainable agriculture in consideration of human health and a healthy environment.

Figure 22

Adaptation Options to Overcome Drought Hazard to the Value Chain: A) Cabbage; B) Potato

CABBAGE POTATO	BARRIERS		
VC STAGES Stage 1 Provision of seeds and other inputs	High cost of adoption; Limited access to credit; Lack of financial benefits Long pay back periods	Lack of human capacity No access to technical equipment Lack of technical capacity;	Climate change beliefs; Short term thinking; Conflicts with traditional methods
Stage 2 On-Farm production	Limited access to credit; Long pay back period Lack of financial benefits High cost of adoption;	Lack of human capacity Lack of technical capacity; No access to technical equipment	Climate change beliefs; Conflicts with traditional methods Short term thinking;
Stage 3 Harvesting storage and processing	High costs of adoption; Limited access to credit; Long pay back periods; Lack of financial benefits	Lack of human capacity; Lack of technical capacity; No access to technical equipment	Short term thinking; Conflicts with traditional methods Climate change beliefs;
Stage 4 Product marketing	High cost of adoption; Long pay back periods; Lack of financial benefits Limited access to credit	Lack of human capacity Lack of technical capacity; No access to technical equipment	Climate change beliefs; Short term thinking; Conflicts with traditional methods

CABBAGE POTATO	BARRIERS	
VC STAGES Stage 1 Provision of seeds and other inputs	Low awareness of climate smart techniques Lack of climate information services	Low institutional support Lack of regulatory framework Weak linkages within government
Stage 2 On-Farm production	Low awareness of climate smart techniques Lack of climate information services	Lack of regulatory framework Weak linkages within government Low institutional support
Stage 3 Harvesting storage and processing	Low awareness of climate smart techniques Lack of climate information services	Low institutional support Lack of regulatory framework Weak linkages within government
Stage 4 Product marketing	Low awareness of climate smart techniques Lack of climate information services	Low institutional support Weak linkages within government Lack of regulatory framework

The lack of a regulatory framework particularly on the price of vegetables in the market is a major institutional hindrance to adaptation. As such, prices are controlled by middlemen and farmers have no insurance of a positive revenue after harvest. It is recommended for each municipality to have a crop programming or zoning system. However, some are skeptical of new methods and marketing systems. A weak linkage within government line agencies was also observed as a barrier. Governments are called to have a collaborative effort in addressing issues. Low institutional support was one issue raised. There were trainees who would have wanted to apply the technologies they experienced abroad but were not supported when they came back to the country.

For farmers who claim low awareness of climate-smart techniques and lack of climate information services, extension services should be strengthened. There are farmers who just focus on farm activities and do not bother with information updates. The conduct of trainings and seminars on climate change information, adaptation, and mitigation is therefore beneficial.

Climate Impact on Gender

Impacts on men, women, youth, and children. Gender roles and relations in the Philippines are strongly influenced by cultural, social, and economic factors; and substantial gaps remain between men and women concerning access to resources, economic opportunities, and influence in decision-making (Hwang et al., 2011; Illo, 2010; Layton & MacPhail 2013). In both urban and rural areas, women are solely responsible for reproductive tasks (i.e. child care, household basic needs, food preparation, etc.) but also actively participate in productive tasks (i.e. agricultural labor or non-farm income-generating activities), whereas men only engage in productive activities (Mason & Agan, 2015; Mishra et al., 2017). Women customarily manage and allocate all household incomes and finances given to them by their husbands (Mason & Agan, 2015). Yet women's labor contributions – both productive and reproductive – are often overlooked, undervalued, or invisible for women in both male- and female-headed households (Mishra et al., 2017). Philippine women are marginalized in decision-making power and influence, as well as in access to land and other resources, capacity building, training, and income-generating opportunities (Lu, 2010; Mishra et al ., 2017).

Figure 23 exhibits the level of engagement of men, women, youth, and children in the four stages of rice, corn, cabbage, and potato value chains. The higher the bar, the greater the level of engagement.

Men. Men take the lead in the purchase of seeds and other inputs, on-farm production until harvesting, storage, and processing of rice, corn, cabbage, and potato. They are the key actors in the marketing of products except rice.

Women. Women are more involved in the purchase of seeds and other inputs for rice and corn and to a lesser degree for cabbage and potato. However, they contribute as much labor as men in the on-farm production of corn, cabbage, and potato and secondary role in rice. They are as active as men in the harvesting, storage, and processing of cabbage and potato. Their least involvement is in the harvesting, storage, and processing of corn. However, they are the lead actors in the marketing of rice and corn.

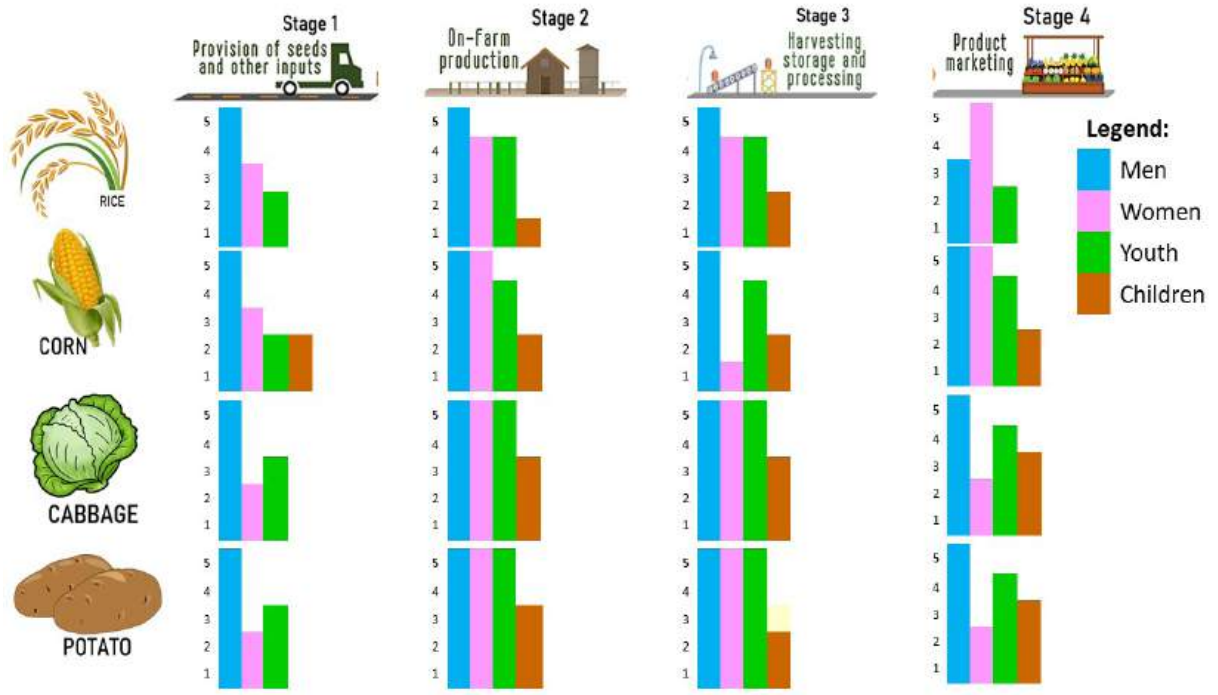
Youth. Youth, especially young men and teenage boys rank third in terms of their engagement in the provision of seeds and other inputs but contribute as much labor as men and women in on-farm production. Their major contribution is labor during harvesting, storage, and processing. The youth are more involved in the marketing of cabbage and potatoes than women except for rice where the former takes the lead.

Children. The involvement of children is more on the on-farm production of cabbage and corn, harvesting of cabbage, and marketing of cabbage and potato. They are engaged to a lesser extent in the provision of seeds and other inputs and on-farm production of corn, harvesting of rice, corn, and potatoes, and marketing of corn. Their least contribution is to the harvest of rice. They are not involved in the provision of seeds and other inputs in rice, cabbage, and potato and the marketing of rice.

Men and women experience climate hazards differently, as they experience different vulnerabilities. In general, men are more exposed to climate risks and hazards. They are engaged almost exclusively in physically-demanding labor

Figure 23

The Role of Men, Women, Youth, and Children Across the Different Value Chain Stages



even during harsh conditions, such as checking the farm/s and restoring eroded areas during and after a typhoon (e.g., carrying stones to riprap the affected area/s), exposing themselves to strong winds and heavy rains. Some farmers even take the risk of transporting their produce during a typhoon in the hope of catching a high market price. In this case, they are responsible for harvesting, hauling, and transporting the produce.

Conclusions

The government, through its regional offices, and its institutional partners including research institutions and Non-Government Organizations has intensified efforts to promote climate-resilient agriculture to increase farm resilience and productivity. Their programs were directed towards the provision of inputs (seeds, equipment), development of climate-resilient crop varieties, establishment of facilities (storage, trading centers), provision of financial services, and delivery of trainings, FFS, and educational programs to build farmer's technical and entrepreneurship skills.

However, the uptake of climate –smart practices across the Value Chains continues to be confronted with a series of informational, financial, and institutional barriers. These include, among others: a) low awareness of adaptation opportunities and limited technical skills to implement them; b) low financial capacity to make long –term investments in technology and equipment; c) capital-intensive on-farm resilience-building activities; d) limited access to insurance schemes; e) unfavorable market prices and f) lax implementation of mandates and management of budgets for climate change action across key government institutions working on agriculture.

Recommendations

Numerous opportunities presented themselves across the value chains to establish public-private partnerships that promote the adoption of climate-smart interventions. A more effective, systematic, and concerted action by various stakeholder groups at all stages of the value chain is recommended in the planning and implementation of these interventions to build resilience and increase agricultural productivity and income. Leveraging financial and informational resources from private, research, and non-governmental agriculture organizations must be strengthened to close investment gaps, increasing capacity to support short, medium, and long-term climate adaptation efforts in the agriculture sector. Some promising strategies include: a) the development of a timely distribution network for seeds, equipment, and other inputs; b) the provision of a weather-based insurance scheme blending private and public sector insurance and opening up the market; and c) the development and maintenance of irrigation and road infrastructure projects to enable production and market access. Finally, policies to facilitate the establishment of said private-public partnerships will better enable agriculture value chain actors to implement the range of adaptation options prioritized.

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