PHILIPPINES
CLIMATE RISK PROFILES

HIGHLIGHTS

- Agriculture is a major contributor to the economy of the Visayas island group, responsible for over five percent of the Regional Gross Domestic Production (GDP) and employing almost three million people.

- The agricultural sector in Visayas is plagued by a variety of challenges including a reliance on rainfed agriculture, a lack of information dissemination regarding new technologies and best practices, agricultural labor shortages, and limited access to financial capital, among others.

- The Philippines is one of the most vulnerable countries to climate change in the world, with climate impacts disproportionately affecting agricultural and rural communities. The country is affected by a range of climate impacts and extreme weather events including droughts, temperature extremes and typhoons. Super typhoon Haiyan was especially devastating, causing PHP $31 billion in damages in 2013.

- Adaptation options to combat the negative consequences of climate change and extreme weather events were proposed across the value chain. Adaptation options included: improved post-harvest storage infrastructure, crop insurance, improved crop varieties, water harvesting techniques (including farm dams, water impoundment and rainwater collection), diversified farming systems including integrated crop-livestock systems and alley cropping between coconut trees (e.g. banana and other annual crops), and improved forecasting and dissemination, among others.

- Common barriers to these measures include challenges in communicating the benefits and effectiveness of adaptation strategies to traditional or difficult-to-reach farmers, insufficient financial resources and limited access to credit. In the aftermath of major catastrophes such as typhoon Haiyan, farmers often lack the financial capacity to clear their lands of debris before replanting.

- A host of climate change specific policies and programs exist to support rice, corn and coconut value chains in Visayas including the Philippine Climate Change Adaptation Project and Adaptation and Mitigation Initiative in Agriculture. One particularly successful programs conducted is the Sustainable Corn Production in Sloping Areas initiative implemented by the Bureau of Soils and Water Management which was able to establish community based techno-demo farms benefiting corn production dependent families.

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FOREWORD

The Philippines is one of the most vulnerable countries to climate change [1], with climate impacts disproportionately affecting agricultural and rural communities. Low productivity, underinvestment and extreme weather events, mean farmers in the Philippines as some of the poorest people in the country, the majority of which manage small farms of less than 1 hectare (ha). The agricultural sector employs some 32% of the Philippines' working population and occupies almost 41% of the country's land area. Comprised of over 7,600 islands—with 11 providing the bulk of the country's landmass—the country faces severe challenges in meeting domestic food demands and relies heavily on imports, especially for wheat and rice.

The Philippines is affected by a range of extreme weather events, particularly tropical cyclones (or "typhoons") [2]. In this humid, tropical environment, climate change is expected to produce even higher temperatures and increasingly unpredictable rainfall by 2050, negatively affecting yields for most crops. In this same period, it is estimated that climate change impacts of all kinds could cost the Philippines' economy over USD 2.7 billion a year [3]. These climate impacts will be exacerbated by rapid population growth, on-going conflict, and severe land degradation. Still, the Government of the Philippines has taken policy and institutional steps to combat the impacts of climate change and adapt the country's agricultural sector to likely impacts.

Given the agricultural sector's importance for poverty reduction and economic growth in the Philippines, it is important to understand the impacts of climate change and extreme weather events across the entire agricultural value chain. To achieve this, three profiles have been created, one for each major island group in the Philippines (Mindanao, Luzon and Visayas), examining the relationship between climate hazards, key commodities, and their value chains. In Visayas, three major value chain commodities (VCC) were selected: coconut (Cocos nucifera), rice (Oryza sativa) and corn (Zea mays). For each of these commodities, a study area was selected through a consultative process supported by relevant literature and expert consultations. The province of Cebu (located in Central Visayas) was chosen for corn and Bohol (Central Visayas) for rice, both due to their high levels of production and recent losses from drought and typhoon. For coconut, Leyte province (Eastern Visayas) was selected as it is one of the major coconut-producing regions and has been consistently adversely affected by typhoons in the past.

The profile is organized into six sections, each reflecting an essential analytical step in understanding current and potential adaptation options in key local agricultural value chain commodities. The document first offers an overview of the county's main agricultural commodities key for food security and livelihoods as well as major challenges to agricultural sector development in the island group. This is followed by identification of the main climatic hazards based on the analysis of historical climate data and climate projections including typhoons and drought. The document continues with an analysis of vulnerabilities and risks posed by the hazards on key commodities through crop suitability mapping and their respective value chains. Based on these vulnerabilities, current and potential on-farm adaptation options and off-farm services are discussed. The text also provides snapshots of the enabling policy, institutional and governance context for adoption of resilience-building strategies. Finally, pathways for strengthening institutional capacity to address climate risks are presented.

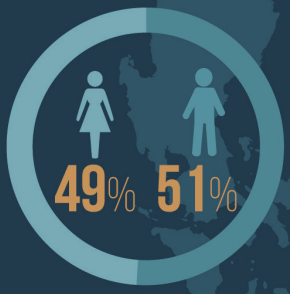
AGRICULTURAL CONTEXT

The Visayas island group is located at the centre of the Philippine archipelago and is the smallest of the three island groups in terms of land area (Luzon is the largest, followed by Mindanao). Visayas is composed of three regions: Western (Region VI), Central (Region VII) and Eastern Visayas (Region VIII). The major islands of Negros Occidental, Guimaras and Panay form Western Visayas; Central Visayas is made up of Cebu, Bohol, Siquijor and Negros Oriental, while Eastern Visayas is composed of Samar, Leyte and Biliran.

DEMOGRAPHICS

19% OF THE PHILIPPINES' POPULATION

19,000,000 INHABITANTS



70% LIVE IN RURAL AREAS

FOOD SECURITY

27% OF THE POPULATION SUFFERS FROM **FOOD POYERTY**

44% OF HOUSEHOLD **INCOME SPENT ON FOOD**

26% CHILDREN **UNDERWEIGHT**

40% CHILDREN **STUNTED**

7% CHILDREN **WASTED**

3% CHILDREN **OVERWEIGHT**

VISAYAS

FARMING

TOTAL LAND AREA (HA) **5.9 MILLION**

AGRICULTURE AREA (HA) **1.9 MILLION**

32% OF TOTAL LAND AREA

PEOPLE EMPLOYED IN AGRICULTURE PRODUCTION **2.7 MILLION**

11% OF

26% OF

ACCESS TO BASIC NEEDS

28% OF THE POPULATION LIVES IN **ABSOLUTE POVERTY**

WOOD FOR COOKING **66%**

ELECTRICITY FOR COOKING **2%**

ELECTRICITY FOR LIGHTING **79%**

SOURCE: PSA.GOV.PH

ECONOMIC RELEVANCE OF FARMING

The Visayas island group accounted for 16% of the country's Gross Value Added (GVA) in the agriculture, hunting, forestry and fishing sector, with Mindanao contributing 33% and Luzon the remaining 51% [4]. As such, the agricultural sector is a major employer in the region engaging over 2.7 million people, representing 26% of the male population and 11% of the female population.

Agricultural work is predominantly carried out by men, representing 65-79% of those employed in agriculture across the regions [5]. The daily agricultural wage rate was fairly consistent across the regions, ranging from PHP $231/day (USD $4.26) in Central Visayas to PHP $245/day (USD $4.52) in Western Visayas. On average, female farm workers earned less than their male counterparts. Both male and female agricultural incomes in Visayas fall below that of the other island groups, especially compared to Luzon where farmers earn, on average, 27% more (33% more when adjusted into real terms) [6]. A consequence of low incomes is that farming households in Visayas earn only 50% of their income from on-farm activities, turning to other more lucrative off-farm activities to generate additional income [6].

PEOPLE AND LIVELIHOODS

Visayas is home to over 19 million people, representing 19% of the country's total population [7]. Of the island groups population 70% resides in rural areas. Agricultural households and the rural population in the Philippines are disproportionately impacted by poverty compared to those living in urban areas, with the incidence of poverty amongst agricultural households at 57% compared to 17% for non-agricultural households in 2009 [8]. Almost a third (28%) of the population in Visayas suffers from absolute poverty [9].

Food security is also a challenge, with food poverty impacting 27% of the Visayan population [9]. Consequently, Visayas has the largest proportion of its population who are underweight (26%) and stunted (40%) compared with the other island groups. Underweight is common in children aged 10 and below, while stunting is prevalent among youth under 19 years old. Undernourishment remains a challenge in Visayas with a relatively high proportion of household income (44%) spent on food [10].

AGRICULTURAL ACTIVITIES

Despite having the smallest land area among the major island groups in the country, an estimated 1.9 million ha are used for agricultural activities, equivalent to 32% of the total land area of Visayas. The main agricultural activities in Visayas are crop production, livestock rearing (hogs), aquaculture, and fishing. Rice, corn, coconut, and banana are the top agricultural crops grown on the island group.

Aggregately, the Visayan islands contributed 18% of the country's rice production in 2017, equivalent to 729,000 metric tons—consistent with historical averages for the region. Another important crop in this island group is white corn, which is consumed as an alternative to rice. Its annual production in 2017 accounted for 14% (297,000 metric tons) of total national production and Visayas has been able to maintain its annual production at this level over the past decade [11].

Coconut is predominantly produced in Eastern Visayas, and aggregately, the Visayan group of islands contributed 1.9 million tons of coconut in 2017, which represented 14% of total Philippine production. Contrary to rice and corn production, the average production of coconut has shown a declining trend. Between 2008 and 2017, average coconut production has fallen by three percentage points, from 17% to 14% of the national total. Regardless, Visayas and Eastern Visayas, in particular, remain one of the top coconut-producing regions in the country [11].

STUDY AREAS AND THEIR AGRICULTURAL VALUE CHAIN COMMODITIES

Considering the importance of agriculture to Visayas, climate variability and hazards may pose a serious threat to the sector. For this analysis, rice, white corn and coconut agricultural value chains were selected for detailed analysis. This selection was informed by these crops' large contributions to total agricultural production as well as their vulnerability to the impacts of climate change. These three crops were identified as key to food security and livelihoods by the Philippines' Climate-Resilient Agriculture Profile [12].

To examine these VCCs in detail, three provinces were selected where these crops feature centrally in the local economy and where climate change is likely to adversely affect production: Bohol (Region 7) for rice, Cebu (Region 7) for white corn and Leyte (Region 8) for coconut. Bohol is located in the south-eastern part of Central Visayas (Region 7) and has a terrain that is mostly rolling and hilly. Cebu, located west of Bohol, is characterized by rolling hills and rugged mountain ranges. Both are major island provinces in the region, surrounded by beaches, coral reefs, and rich fishing grounds. Meanwhile, Leyte is in the southern part of Eastern Visayas (Region 8) with a terrain that ranges from relatively flat to rolling and mountainous, large forests can be found in the centre of the island.

CEBU

WHITE CORN

White corn is one of the most important food crops in the Philippines. After rice, it is the staple food for around 20% of the population, primarily in the southern regions of Visayas and Mindanao. In times of economic hardship white corn is consumed as a substitute for rice given its abundance and low price [13].

Farm inputs for corn include seeds, fertilizer—both organic and inorganic (chicken dung, complete fertilizer urea and potash)—and pesticides when needs arise. Available seeds include traditional varieties, open-pollinated varieties (OPV), and hybrid corn. Cropping systems adopted by farmers include monocropping, crop rotation (e.g., corn-mung bean and corn-peanut) and corn intercropped with Mung Bean or peanut during the second cropping. Pest and disease management strategies include the use of biological agents (e.g. trichogramma cords) to control corn borer and chemicals for particular pests like Army Worm. Tractor services—along with a fuel subsidy—are offered by the Department of Agriculture (DA) through Municipal Agriculture Offices (MAO). In some areas, corn farmers practice zero-tillage, especially in hilly areas. Farmers typically double crop corn each year, with the first cropping from May to June and the second beginning after the October harvest.

The key actors involved in the corn value chain are input suppliers, farmers, hired laborers, farm owners, post-harvest processors such as corn dryers and millers, the government, traders and wholesalers. Farmers are charged with all on-farm activities as well as many post-harvest tasks like storing, drying, de-husking, shelling, and delivery to buyers or corn millers. Men are actively involved in labor-intensive activities, such as land preparation, planting, and transporting produce. Women, meanwhile, are involved in the marketing and selling of the corn.

SA1

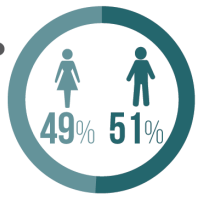
DEMOGRAPHICS

2,938,982
TOTAL POPULATION

15% OF TOTAL POPULATION IN **VISAYAS**

3% OF TOTAL POPULATION IN **THE PHILIPPINES**

62% LIVE IN **RURAL AREAS**



PERCENTAGE OF **FEMALE AND MALE** POPULATION

ACCESS TO BASIC NEEDS

34% OF THE POPULATION LIVES IN **ABSOLUTE POVERTY**

99% ARE **LITERATE**

FARMING

AGRICULTURE
AREA (HA) **146,056**

NUMBER OF FARMS
156,078

SA2

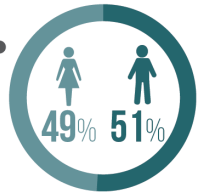
DEMOGRAPHICS

1,313,560
TOTAL POPULATION

7% OF TOTAL POPULATION IN **VISAYAS**

1% OF TOTAL POPULATION IN **THE PHILIPPINES**

90% LIVE IN **RURAL AREAS**



PERCENTAGE OF **FEMALE AND MALE** POPULATION

ACCESS TO BASIC NEEDS

23% OF THE POPULATION LIVES IN **ABSOLUTE POVERTY**

98% ARE **LITERATE**

FARMING

AGRICULTURE
AREA (HA) **136,613**

NUMBER OF FARMS
123,487

SOURCE: PSA.GOV.PH

Farmers have access to inputs through government agencies like the Department of Agriculture (regional, provincial and municipal level). Different agencies such as the DA, Agricultural Training Institute (ATI), Philippine Crop Insurance Company (PCIC), and Local Government Units (LGUs) provide crop insurance, demonstration farms, farmer field schools, and training programs for corn farmers. These agencies also provide foundation seeds and other farm inputs together with private companies (e.g., Agrivet), seed growers and some larger-scale farmers.

Corn millers, meanwhile, process the dried corn kernels into corn grits that are then sold in the market for consumption (corn grits are typically the end product of the corn, although occasionally corn grits are turned into corn coffee). Millers also produce corn bran and feeds, which are sold to traders or directly to consumers. Most corn mill owners employ middlemen to negotiate directly with farmers to buy their product in bulk. Increasingly, with the entrance of larger milling operations, small scale corn millers are experiencing reduced operations.

BOHOL

Agriculture is the largest sector in the province of Bohol in terms of land use (about 136,000 ha or 66% of all land) and employment. The major crops planted in terms of land area include rice (51%), coconut (24%), and corn (9%) [14].

RICE

Rice accounts for 35% of the average caloric intake of most Filipinos. Bohol is considered the "Rice Granary of Central Visayas" and is the main rice-producing province. Harvested rice area in Bohol is approximately 72,000 ha, producing 238,728 metric tons and accounting for nearly 75% of all regional production [11]. Rice production in Bohol occupies over half of all arable land in the province. Most rice farmers practice mono-cropping with two crops per year, while only a small minority practice organic farming. Not all farmers have access to irrigation and many are depended on rianfed production. Most farmers use mechanization for land preparation.

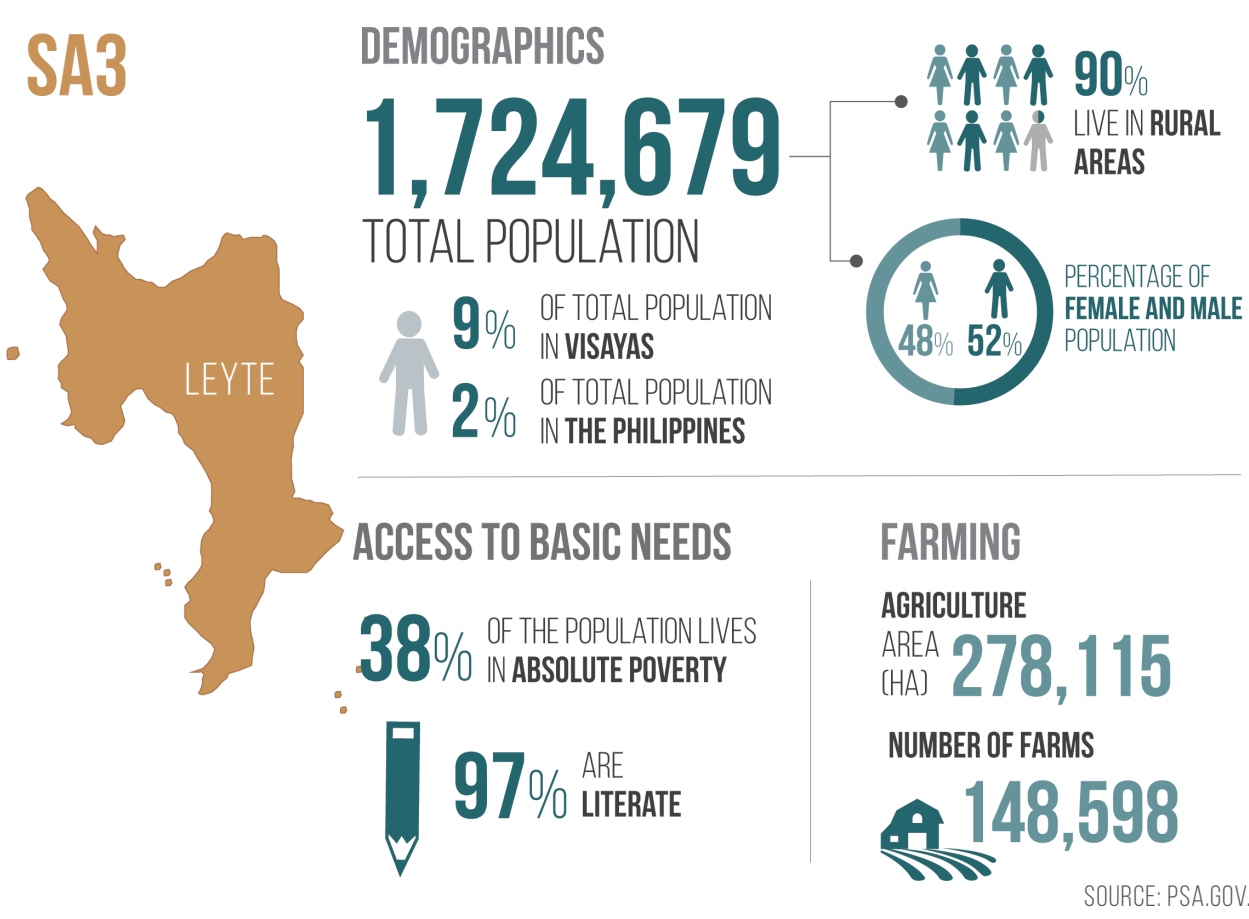
The key actors involved in the rice value chain are input suppliers, farmers, hired laborers, post-harvest processors, traders, retailers, and wholesalers. Input suppliers provide farmers with inputs like seeds, fertilizers, herbicide, pesticide, tools, and equipment. Often, the International Rice Research Institute provides genetic material to PhilRice to produce foundation seeds for the Department of Agriculture. These seeds are then distributed to cooperatives and LGUs. Farmers are responsible for on-farm production and produce different varieties of rice, such as black, white and red rice. Farmers and hired laborers manage most on-farm activities including land preparation, planting, management (weeding, fertilizing and pest control) and harvesting. Farmers also participate in post-harvest activities like storage and drying (when buyers demand that the produce be dried and ready for milling, for example). Women are involved in rice farm activities that are less rigorous or labor-intensive, especially the pulling of seedlings. Still, 50% of women are involved in transplanting, weeding, and harvesting. Women are also often involved in selling, store tending, and other activities.

Small-scale farmers often borrow from traders for farm inputs, paying back these loans immediately after harvest. The Landbank of the Philippines also provides financial assistance to cooperatives and farmers. Different institutions such as Universities, the National Irrigation Administration, ATI and PCIC provide trainings, workshops, and insurance to farmers and seed growers. Rice millers, meanwhile, are typically private entities or cooperatives, purchasing from private traders or other cooperatives and selling the milled product to wholesalers, retailers, or directly to consumers.

LEYTE

COCONUT

Coconut is the second most dominant crop in Eastern Visayas next to rice and is the country's top export commodity [15]. For many farmers in Leyte, coconut is described as the "tree of life" given the diversity of income sources it offers. Coconut farming is a very important source of economic activity among farmers across Leyte and Samar islands. Earnings from the coconut industry— USD $1.58 billion from 2009 to 2011—ranked higher than any other agricultural commodity. There are many products from coconut like wine, vinegar, lumber, charcoal, herbal medicines, and fresh coconut meat. Dried coconut, copra meal, and coconut oil, however, are among the top coconut export products, exporting USD 1.3 billion in 2016 alone [16].



It is estimated that 33 million coconut trees covering 300,000 ha were damaged by typhoon Haiyan, jeopardising the livelihoods of more than 1 million farming households [17]. Prior to Haiyan, coconut production in Leyte reached 526,559 metric tons a year planted on 167,974 hectares. In the following year production fell by more than 50% to 194,050 metric tons covering a total farm area of just 94,744 hectares (a 43.6% reduction in area) [5]. By some estimates, it will take 6 to 9 years before coconut returns to full production, threatening the livelihoods and food security of many families.

The key actors involved in the coconut value chain are input supplier, farmers, hired labor, traders, retailers, and wholesalers. In Leyte, the National Coconut Research Center, Visayas State University, and the Philippine Coconut Authority provide seed nuts or seedlings to farmers along with (historically) salt as fertilizer for the coconut trees. Still, most coconuts used for planting by farmers are from their own harvests. LGUs and the Philippine Crop Insurance Company provides inputs, training, and insurance to farmers.

Farmers participate in on-farm activities like clearing, land preparation, planting, and harvesting. Women in coconut farming are mainly involved in less labor-intensive activities, with the exception of separated, widowed, or single mothers who often undertake all tasks. The main coconut product is copra. Copra, however, undergoes several transformations to produce different products like whole nuts, virgin coconut oil, soap, beauty products and more. These are produced in processing plants requiring proper facilities and a skilled labor force. These various coconut products are then marketed through traders, wholesalers and retailers. Farmers sell their copra to private entities or cooperatives and these buyers are responsible for selling the consolidated copra to the processors such as SC Global. Women are especially involved in canvassing for potential markets and price negotiations both for end product (price is often determined by the buyer) as well as for hauling and transport services. The National Coconut Research Center promotes the commercialization of various products like cocofresh, macapuno ice cream, coconut biscuits, wine, and others.

AGRICULTURAL SECTOR CHALLENGES

The agricultural sector in Visayas hosts an array of challenges whose impacts are felt across the value chain. If not addressed these challenges will continue to constrain the sector, resulting in yields and incomes below their potential. For a sector characterised by poor subsistence agricultural production and small scale value chain actors such losses are felt acutely.

Labour

Income generated by agricultural workers is less than half that of the average worker in the Philippines. Consequently, 66% of those in the country who are considered working poor are engaged in the agricultural sector [18]. While the wider economy experiences economic growth and rising incomes, the basic pay rate in the agricultural sector has remained stagnant. Workers seeing greater opportunities in off farm labour are either moving to urban areas or demanding higher incomes [18]. The introduction of cash assistance programmes (including the Bridging Program for the Filipino Family and the Modified Conditional Cash Transfer Program) for those living below the poverty line has disincentivized farm labourers from engaging in low paid labour. While such measures are highly necessary to support vulnerable families, farmers faced with higher costs of production that were not reflected in the market price of their cops, saw their real incomes fall. Farmers in Bohol reported on rice harvests being missed due to labour shortages, despite unemployment in agriculture remaining high. Labour shortages are partly due to the highly seasonal nature of agricultural labour in the Philippines, with excess supply during the growing season and excess demand during planting and harvesting, creating an unstable income source for labourers.

Mechanisation

Increased mechanisation would help to ease the demand of labor during land preparation, planting and harvesting. Gains have been made in recent years to increase the level of mechanisation in the Philippines, reaching 2.31 horsepower(hp) per ha in 2013, up from 2.0 hp/ha in 2012 [18]. This does however still lag behind other countries in the region such as Thailand. Much of the investment in mechanisation has been directed towards rice and corn production with the DA through PhilMech investing heavily in the acquisition of farm machinery which are provided to farmer organisations [19]. There are still very limited mechanisation options for coconut production.

Infrastructure

Absent of decaying rural infrastructure represents a major challenge for farmers, especially for those in remote areas. Inadequate irrigation infrastructure and poor quality farm to market roads were identified as major constraints. The impacts of poor infrastructure are felt more acutely in times of extreme climatic events such as droughts and typhoons (see section 3). The absence of good quality farm to market roads reduces the options available to farmers when selling their goods, leaving them as price takers. An ADB study measuring the impact of rural infrastructure provided through the Agrarian Reform Communities Project (ARCP) found farm to market roads had the greatest impact on rural communities when compared to other infrastructure projects (communal irrigation & potable water supply). It did however observe that the richer members of the community were the largest beneficiaries from improved market access, increasing existing income inequalities [20], especially when local communities don't have the means to capitalise on the increased access [21]. Recognising the need for improved irrigation systems under drought, large investments have been made in Visayas including the National Irrigation Sector Rehabilitation and Improvement Project (NISRIP) supported by JICA [22].

Credit

The adoption of new technologies or practices in response to climate change and extreme weather events often represents a cost to VC actors, particularly farmers [23]. In many instances the upfront costs of adopting new methods preclude uptake, as actors don't have the financial capital and can't access credit. Often, farmers are unable to sufficiently finance on-farm expenses resulting in limited inputs and supplies which results in low yields. Or, farmers operate under a scheme where they are loaned input by the provider, income generated by selling the produce is used to pay back the loan. Such loans are often at unfavorable rates, or in some cases leave the farmer splitting the profits 50:50 with the input provider.

IMPACTS ON WOMEN AND YOUTH

Gender roles and relations in the Philippines are strongly influenced by cultural, social, and economic factors. Substantial gaps remain between men and women with respect to access to resources, economic opportunities, and influence in decision making [24,25,26]. Many women are marginalized in decision-making power and influence, lacking access to land and other resources, capacity building, training, and income-generating opportunities [27]. In both urban and rural areas, women are solely responsible for home-related tasks (i.e. child care, household basic needs, food preparation, etc.) whereas men engage primarily in production-related activities (i.e., agricultural labor or non-farm income generating activities) [28]. Generally speaking, women customarily manage and allocate all household income and finances provided by their husbands [29]. There are some notable exceptions to these generalized gender norms. In corn systems, in particular, women are actively involved in seed and input provisioning and product marketing. In fact, women in Cebu province are relatively more active across the corn value chain than are women in rice or coconut value chains in Bohol and Leyte provinces. Separated, widowed, or single mothers often undertake all value chain tasks including more labor-intensive work. In the event of a failed harvest due to drought, women seek off-farm employment such as serving as domestic helpers. Still, women's labor contributions are often overlooked, undervalued, or invisible in both male- and female-headed households [29]. Elderly women, women with children, pregnant women and women with disabilities are the most vulnerable to production and value chain shocks.

Figure 1: The role of men, women, youth and children across the different VC stages. Results collected through expert workshop with key VC actors in Cebu.

It is estimated that up to 2.1 million Filipino children remain trapped in child labor, with agriculture responsible for a large proportion (62%). Boys and those living in rural areas are disproportionately impacted, being twice as likely to be involved than their female and urban counterparts. The most prominent form of labor is that of an unpaid family work. The impact of children's engagement in labor activities is often to the detriment of their education, with children absent or too tired to actively participate in their schooling [30].

CLIMATE CHANGE AND VARIABILITY: HISTORIC AND FUTURE TRENDS

CLIMATE CHANGE AND VARIABILITY: HISTORIC AND FUTURE TRENDS

The Philippines, by the nature of its geographical location and archipelagic formation of over 7,000 islands, is highly vulnerable to the impacts of climate change. This vulnerability is the result of its high exposure to multiple hazards, the human and economic sensitivity to these hazards and its limited adaptive capacity [2]. Globally, The Philippines is ranked 5th in terms of climate-related losses for the period of 1997-2016, with 289 events killing 85,955 people and costing 0.6% of GDP [1]. The impacts of climate change in the Philippines is felt most acutely by farmers and those living in rural areas, with typhoons, flooding and droughts damaging crops and property. From 2000 to 2010, the total economic damage from typhoons, floods, and droughts was estimated to cost the Philippines USD $2.23 billion, including crop losses for rice (USD $1.2 billion), maize (USD $461.50 million), and high value crops (USD $244.82 million) [31]. By 2050, this figure is projected to rise to USD $2.7 billion a year [3].

CLIMATE TYPE

Based on the Modified Coronas Classification System for climate typology, Visayas is comprised of all four climate types present in the Philippines [32]. The eastern side of the island (Region 8) is classified as type II with no dry season and a pronounced period of heavy rain from December to February. The center of the island (Regions 7 and 8) are classified as type IV with rain distributed evenly throughout the year, while the western portion of the island (Regions 6 and 7) are classified as type III with a short dry period from December to February. The western side of Region 6 is classified as type 1 with a pronounced dry season from November to April and wet conditions for the rest of the year.

PROJECTED CHANGE IN PRECIPITATION AND TEMPERATURE BY 2050 [32]

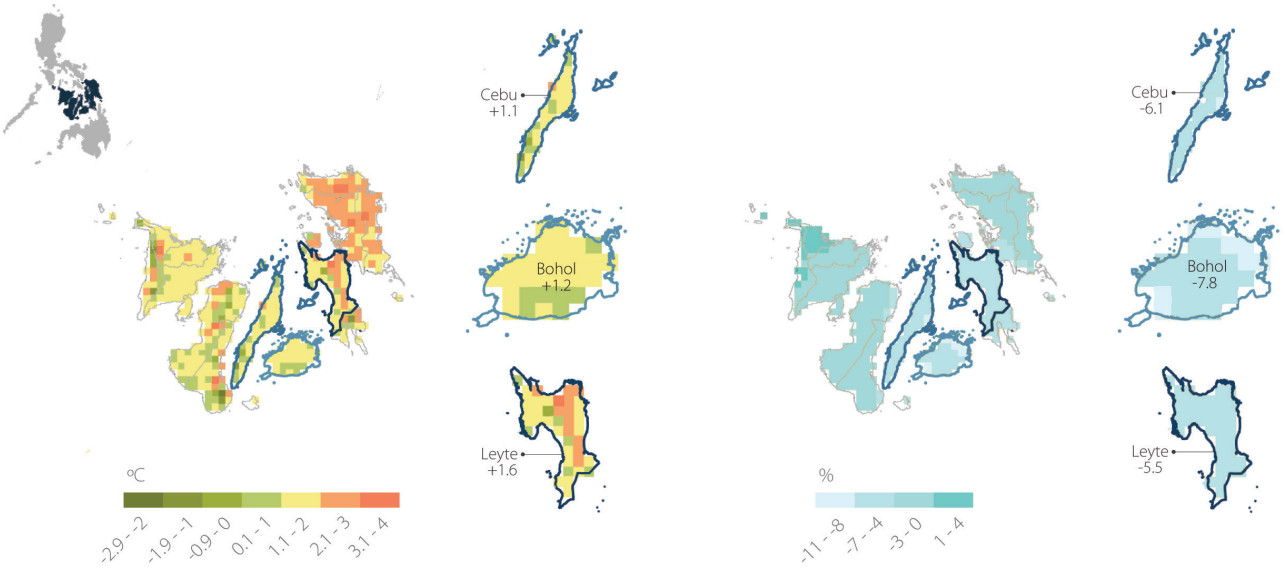


Figure 2: Modelled changes in temperature (left) and precipitation (right) under climate change by 2050, using RCP 4.5.

Mean temperatures in Visayas are projected to increase by the middle of the century, with the largest increase projected in Leyte (+1.6°C), followed by Bohol (+1.2°C) and Cebu (+1.1°C). It is however the projected increases in extreme hot days (>35°C) this will have the greatest impact on crop production [32]. Bohol is projected to see the largest fall in mean rainfall (-7.8%), but will also see the number of days annually with extreme rainfall increase from 15 to 23 (>100mm). Cebu will see a fall in mean rainfall (-6.1%) and an increase in extreme rainfall events from 12 to 17. Leyte follows the same trend as with falling annual rainfall and a small increase in extreme rainfall events [32].

HAZARDS

Globally, typhoons are projected to increase in intensity due to progressive climate change over the coming decades [33, 34]. The Philippines is situated in the Pacific basin, the source of 57% of global typhoons [35]. This makes the country the second most exposed in the world to typhoons after China [36] receiving at least 15 typhoons (aggregate of tropical storms and typhoons) a year [37] Of the three island groups, Visayas was the only one to have experienced an increase in frequency of intense tropical cyclones over the period between 1951 and 2000 [32]. In 2013 Super typhoon Haiyan (Yolanda) made landfall in Visayas with sustained wind speeds of 315 kilometers per hour, making it one of the most powerful tropical cyclones ever recorded. The island of Eastern Samar and much of eastern Visayas sustained considerable damage to infrastructure and the agricultural sector.

A further consequence of typhoons is an increase in storm surges and associated flooding in low-lying coastal areas. The storm surge that followed Typhoon Haiyan in 2013 was among the deadliest storm surges in the last 50 years with an estimated 7,000 fatalities recorded by the Philippine government organization National Operational Assessment of Hazards. The impact of typhoon Haiyan on agriculture was estimated to be USD $241 million, of which USD $195 million was production losses with a further USD $45 million in damage to agricultural infrastructure [38]. Typhoons are identified as the most damaging geophysical hazard to the agricultural sector in the Philippines, with production damage and losses caused by typhoons and storms amounting to USD $3.5 billion, or 95% of all agricultural losses for the 2006 to 2013 period [39].

TYPHOON HAZARD MAP OF VISAYAS [40]

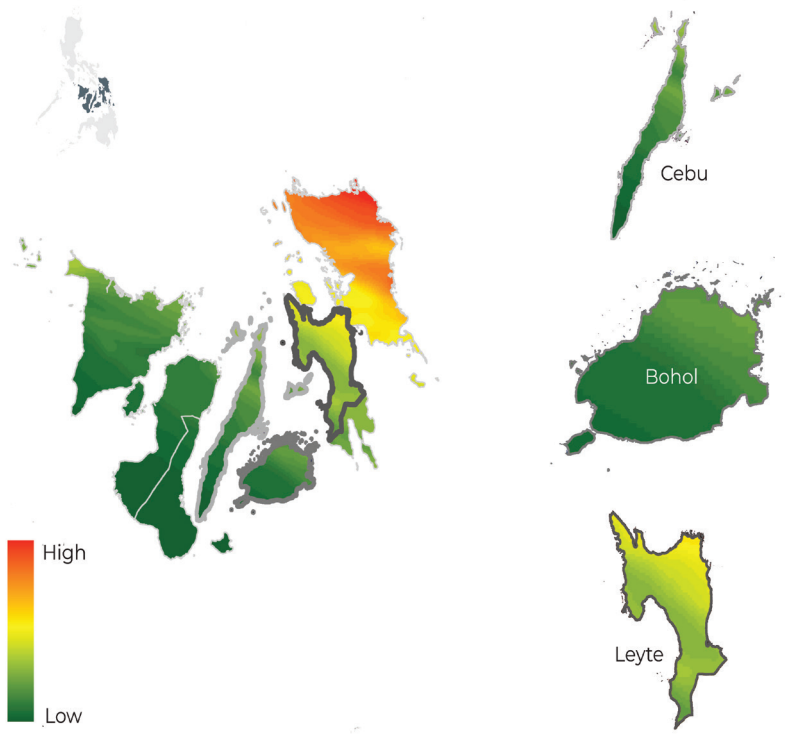


Figure 3: The typhoon map was acquired from the UNEP/UNISDR dataset using a 1 kilometer pixel resolution. Estimate of tropical cyclone frequency based on Saffir-Simpson scale category 5 (> 252 km/hr) from year 1970 to 2013.

DROUGHT HAZARD MAP OF VISAYAS [41]

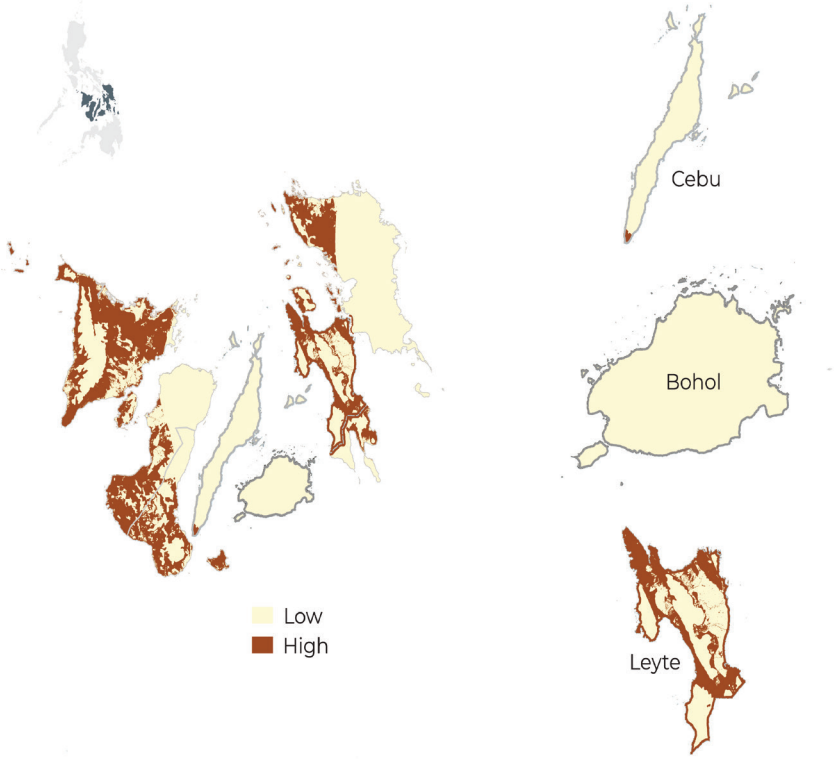


Figure 3: The drought map was acquired from the AMIA 1 dataset. It is produced using the integration of groundwater potential from National Water Resources Board (NWRB), topography, and climate data from PAGASA.

The increase in mean temperatures and hot days experienced in Visayas, coupled with the reduction in rains bought on by the southwest monsoon, have increased the frequency and intensity of droughts [42]. The El Niño Southern Oscillation (ENSO) is a naturally occurring climate phenomenon that impacts much of the tropics. It can be broken down into two phases: El Niño (warm phase) and La Niña (cold phase). The ENSO has a strong modulating effect on rainfall patterns in the Philippines, with El Niño associated with droughts and water stress and La Niña resulting in excessive rainfall [43]. Climate type I experiences the largest positive rainfall anomaly in La Niña years, while climate type III experiences the largest negative rainfall anomaly in El Niño years. The 1997 to 1998 El Niño resulted in production losses of 100% during the dry season and more than 33% during the wet season. This was repeated with the 2004 El Niño but to a lesser extent, causing 18% losses during the dry season and 32% in the wet season [40]. Bohol experienced reduced rainfall as a result of the 2016 El Niño, causing an estimated USD $81 million in losses in Mindanao and Visayas [44].

CROP SUITABILITY MAPPING

The climate change impacts and hazards outlined in the previous section—increased frequency and intensity of typhoons, higher temperatures and increased likelihood of prolonged drought—each impact intimately on agricultural systems in Visayas. By combining climate projections (e.g., temperature and rainfall) with specific parameters regarding a plant's basic physiology, modelling for suitability can provide useful projections as to where favorable growing conditions may exist for certain crops into the future. Suitability mapping for 2050 is provided here for coconut, maize and rice in Visayas (1997-2000 baselines) and ranges) and ranges from 0 to 100%, with intervals being classified as very high (100), high (80), moderate (60), marginal (40), and very marginal (20). These measures for future suitability will assist agricultural planning and investment in the selected regions, supporting long term planning and transformative change in response to climate change.

COCONUT

Today, coconut is generally suitable in almost all the major islands of Visayas with a climate suitability ranging from high to very high. The region does not show significant negative suitability effects of climate change on coconut by 2050, with some areas in the east side of the island becoming more favorable. These suitability projections, however, do not take into account the impact of extreme events such as droughts and typhoon. When typhoon Haiyan made landfall in Visayas it damaged 41,662 ha of coconut production at an estimated cost of USD $28 million [38]. With the frequency and severity of tropical cyclones in Visayas expected to increase, this poses a serious threat to coconut production in Eastern Visayas and Leyte [43].

MAIZE

Historically, corn has high to very high climate suitability throughout Visayas. By 2050, however, there is a marked decline in corn suitability across the island group, with a fall from high to marginal suitability across much of the low-lying areas. This still does not account for the impacts of drought and typhoon which can severely damage production. Corn is highly vulnerable to the impacts of typhoons, with typhoon Haiyan damaging 21,699 ha of corn at an estimated cost of USD $5 million [38].

CLIMATE SUITABILITY OF COCONUT IN VISAYAS, CURRENT AND 2050 [32, 43]

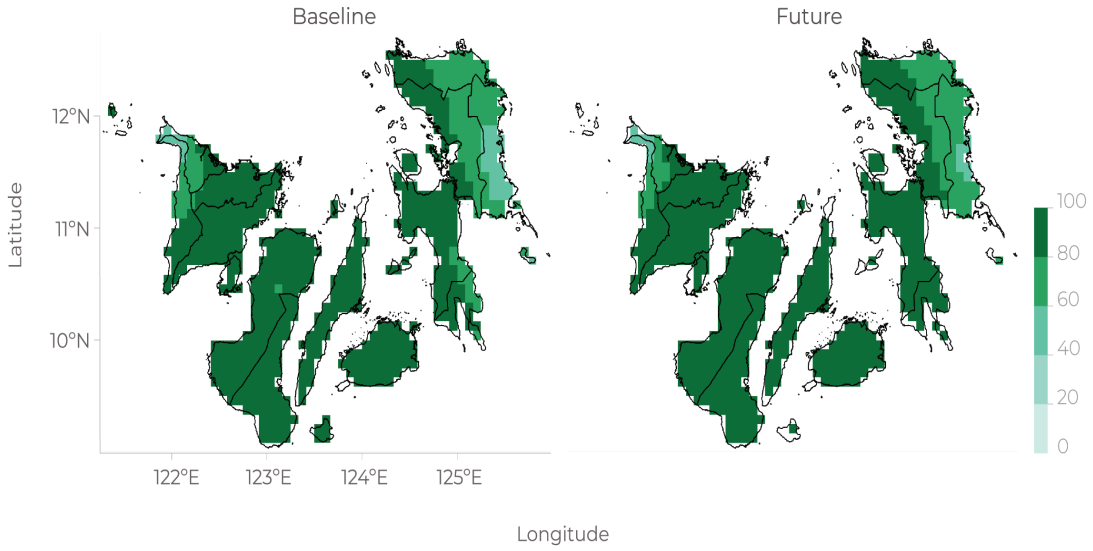


Figure 5: The climate suitability maps represent how well the crop will thrive in an area based on climatic factors such as temperature and rainfall. The suitability ranges from 0–100 percent with an interval of 20: 100 - very high, 80 - high, 60 - moderate, 40 - marginal, and 20 - very marginal.

CLIMATE SUITABILITY OF CORN IN VISAYAS, CURRENT AND 2050 [32, 43]

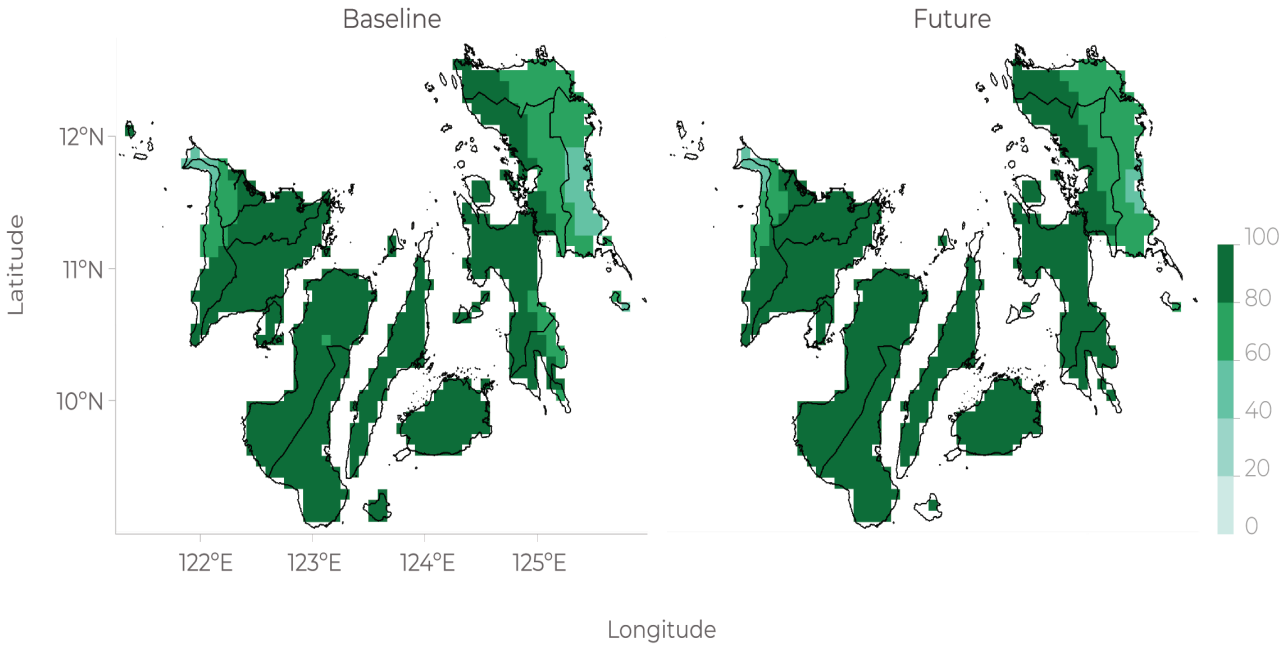


Figure 6: The climate suitability maps represent how well the crop will thrive in an area based on climatic factors such as temperature and rainfall. The suitability ranges from 0–100 percent with an interval of 20: 100 - very high, 80 - high, 60 - moderate, 40 - marginal, and 20 - very marginal.

RICE

Rice is typically suitable in almost all the lowlands of Visayas islands, particularly in the provinces of Aklan, Capiz, Iloilo, Negros Occidental, Cebu, Bohol, Samar, and Northern part of Leyte. By 2050, however, the climate suitability of the crop is expected to decrease in almost all of these areas from very high to highly suitable. Studies conducted in Bohol found that farmers have already observed changes in both temperature and precipitation as a result of climate change [46]. It has been measured that for each 1°C increase in minimum temperature in the dry season, rice grain yields fall by 10% [47], and for every 1% increase in the share of wet days, yields fell by 36 kg/ha [48]. In the wake of typhoon Haiyan, 77,719 ha of rice were impacted, with damages estimated at USD $44 million [38].

CLIMATE SUITABILITY OF RICE IN VISAYAS, CURRENT AND 2050 [32, 43]

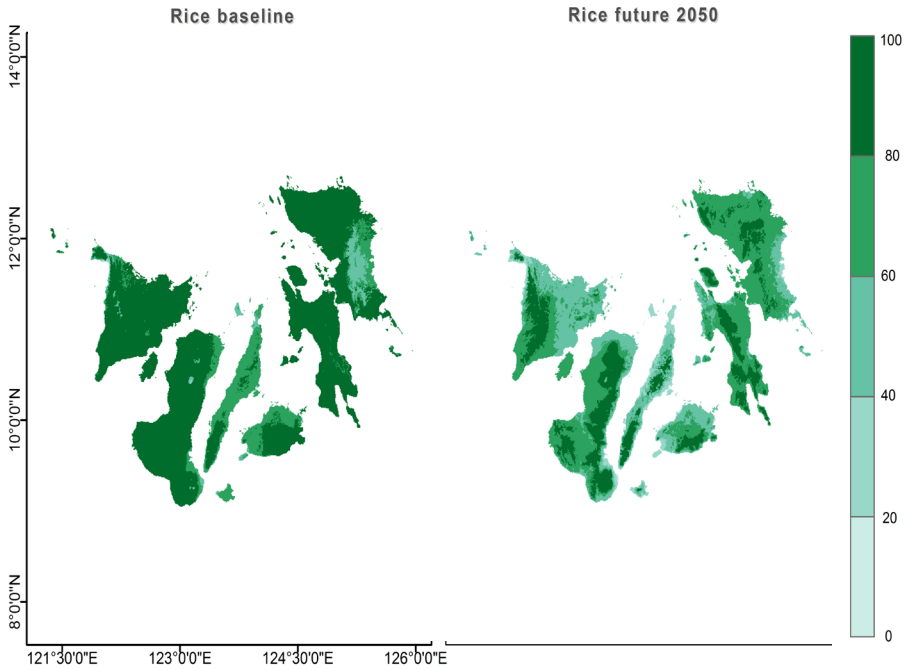


Figure 7: The climate suitability maps represent how well the crop will thrive in an area based on climatic factors such as temperature and rainfall. The suitability ranges from 0100 percent with an interval of 20: 100 - very high, 80 - high, 60 - moderate, 40 - marginal, and 20 - very marginal.

THE CLIMATE FROM FARMERS' PERSPECTIVES

Farmers in all study areas (Cebu, Bohol and Leyte) have observed that weather patterns are growing less predictable when compared to historical trends. Months that are typically dry, for example, are experiencing increased rainy days. In times of extreme heat and drought, some farmers note that even irrigation cannot prevent losses in rice fields as plants still wilt from unsustainably high temperatures. Long dry seasons have adverse effects on coconut farmers as trees produce fewer nuts or bear much smaller fruits. Moreover, the extreme heat is often accompanied by pest infestations.

Farmers have affirmed that the intensity of typhoons and rainfall have increased over time, damaging plants and reducing yields, sometimes resulting in failed harvests. As weather grows increasingly unpredictable and forecasts unreliable or unavailable, planning for on-farm activities has grown more challenging, especially affecting fertilizer application that can be washed away by flooding or heavy rains. Farmers added that extreme weather also affects animal production, adversely affecting these alternative sources of income as well.

VALUE CHAINS, VULNERABILITIES AND PROPOSED ADAPTATION OPTIONS

CORN

The corn value chain in Cebu is vulnerable to the impacts of both droughts and typhoons. Farmers in the region identified a range of consequences bought on by drought conditions. In times of drought the quality and quantity of available seeds drops as farmers seek to replace crops lost or damaged through the increased incidence of pest and disease outbreaks and reduced germination. The consequences of typhoons are felt across the whole value chain, disrupting the transportation of inputs and produce between actors. Low yields and reduced quality of corn due to rotting and pest and disease outbreaks reduced the income earned by farmers with knock on effects across the value chain as processors and traders don't receive sufficient high quality products.

Corn farmers identified the need of early warning systems as an effective adaptation option for both droughts and typhoons, allowing them to take preventative measures, reducing their losses and facilitating recovery. The delivery of early warnings should be made through feature phones in SMS format as many farmers still don't have access to smartphones and/or live in areas with limited connectivity. For farmers who are unaware of how to respond effectively, early warnings should come with targeted advisory on the best resilience building activities.

Diversified farming was also identified as an adaptation option with the potential to reduce losses from both droughts and typhoon, safeguarding food and income security for corn farmers in Cebu. Transitioning from a corn monocrop to diversified farming, integrating livestock and other crops will reduce the vulnerability of farmers by providing multiple income sources. Such a system would also have numerous environmental co-benefits, improving soil quality, reducing the need for synthetic fertilizers and safeguarding agro biodiversity. Another proposed adaptation option is a corn-peanut crop rotation which was found to offer higher yields than conventional production [49].

Typhoons were found to have a moderate to major impact on the harvesting, storage and processing of corn, disrupting transport and resulting in increased post-harvest losses. Two proposed adaptation options are the use of moisture meters and improved storage facilities ensuring harvested corn remains in the optimal conditions.

RICE

Although drought tolerant varieties of rice are being introduced, farmers in Bohol are still facing serious challenges from droughts. During long dry spells or droughts, infestations of army worm, blast and brownspot become more prevalent. Agricultural labor is also affected by extreme hot days, limiting the number of man hours they can work in the field each day. In these instances, proper management practices or technologies are often not applied. This has downstream effects on consumers whose demand for rice is not met, leading to price increases. While on most occasions Bohol is not directly hit by typhoons, these events can damage irrigation infrastructure. Typhoons and heavy rainfall also affect harvesting, storage, and processing given higher labor costs and drying expenses from collapsed or water-logged crops.

The adoption of agro-forestry and diversified farming systems were considered effective adaptation options at a farm level to both droughts and typhoons. The incorporation of trees into rice monocrop landscapes acts as an effective shield from the elements, reducing the damaged caused by heavy rains, high winds and extreme temperatures. The integration of livestock and high value multipurpose trees into farming systems brings additional income sources to farmers, improving their financial stability. Planting nitrogen-fixing leguminous crops on the boundaries of their paddies (sometime referred to as "alley cropping") was identified as an effective adaptation option with positive impacts on yield.

Another promising adaptation strategy is to transition to organic production, reducing input costs and opening up higher value markets. A good example would be the production of red rice using organic

CORN

PROVISION OF SEEDS AND OTHER INPUTS | ON-FARM PRODUCTION | HARVESTING STORAGE AND PROCESSING | PRODUCT MARKETING

Hazard: DROUGHT

Consequences

- Insufficient stock of buffer seeds
- Reduced quality/viability of inputs (e.g. seeds)
- Damage during reproductive stage
- Increases of pest outbreak
- Less-to-no production
- Delays in the implementation of farm activities/operation
- Difficulties to generate employment (hired laborers)
- Reduces yield and quality produces

Underlying vulnerability factors/ sensitive groups

Biophysical: Soil erosion process in hilly areas; **Socio-economic:** low level of partnership/association, low level of education, lack of savings/investment capital after extreme climate impact; **Cultural:** little interest/enthusiasm to be part of groups and attend meetings; **Institutional:** difficulties on access information, lack of insurance services

Adaptation options proposed

- Crop insurance
- Organic fertilizer ($) (chicken manure)
- SMS-generated early warning system/advisory
- Diversified farming ($) (crops-livestock)
- Use of improved varieties
- No weeding
- Application of foliar fertilizer
- Water pump for irrigation
- Organic farming

Hazard: TYPHOON

Consequences

- Insufficient stock of buffer seeds
- Reduced quality or availability of inputs (e.g. seeds)
- Submergence damages crop/knocking over
- Damage during reproductive stager
- Increases of pest outbreak
- Less-to-no production
- Delays in the implementation of farm activities/ operation
- Stoppage of post harvest operation
- Difficulties to produce the quantity for bulk buying (low yield)
- Difficulties in finding hired laborers
- Difficulties to generate employment (hired laborers)
- Low yield and quality produces

Underlying vulnerability factors/ sensitive groups

Biophysical: soil erosion in hilly areas; **Socio-economic:** low level of partnership/association, low level of education, lack of savings/investment capital after extreme climate impact; **Infrastructure:** blockage of roads and bridges access, difficulty to reach markets

Adaptation options proposed

- Crop insurance
- Buffer stock of corn seeds
- SMS-generated early warning system/advisory
- Diversified farming (crops-livestock)
- Organic farming
- Measure using moisture meter
- Use of good storage facilities
- Early harvesting
- Buy fresh corn instead of dried corn

Magnitude of impact: Minor | Moderate | Major | Severe

Score priority: High | Medium | Low

Cost-Benefit Analysis: $ Available

inputs [50]. Organic red rice production in Visayas supports DA-NIR's Promotion and Development of Organic Agriculture Program. It also has garnered strong support from the Negros Island Organic Producers' Association (NIOPA) and is recommended by the Municipal and City Agriculture Office and the Regional Field Office of the Department of Agriculture.

Rice farmer's financial capacity to adopt new practices if often constrained due to limited access to credit needed to cover the upfront costs. Programmes that remove barriers for farmers to access credit would help them to take preventative measures to build their resilience to droughts and typhoons. As all risk cannot be mitigated through the proposed adaptation options, investments must be protected through crop insurance schemes, allowing farmers to transfer their risk.

COCONUT

Typhoon is the most damaging climate hazard for coconut production in Leyte, as evidenced by the devastating impacts on the sector produced by super typhoon Haiyan in 2013. It will take almost a decade for coconut trees to re-grow and for farmers to fully recover their livelihoods as the result of uprooted or truncated coconut trees. Some farmers continue to be impacted by heavy rains and flooding, especially those in open and low-lying areas highly exposed to strong winds and rains. Drought can also adversely affect coconut trees, resulting in wilting and drying of leaves and button shedding.

For coconut farmers in Leyte, periods of drought are also accompanied by an increased incidence of in pest and disease outbreaks. In these moments, farmers may choose to adopt integrated pest management strategies, including the use of bio-controls to prevent pest infestations and disease outbreaks. Manual spraying of trees may also serve as an adaptation strategy for some farmers, and in some extreme cases, controlled burning of heavily infested or diseased trees may be required. In extreme drought conditions, seedlings, which are not typically watered, may be irrigated to ensure their survival.

Diversified farming systems may also be adopted by farmers facing drought conditions, including integrated crop-livestock systems and alley cropping between coconut trees (e.g., banana and other annual crops). In a recent study, coconut-banana intercropping was found to be an effective crop diversification adaptation option. Intercropping of banana in areas planted with coconut was found to significantly increase farm productivity, compared to coconut mono-cropping. The practice also requires minimal fertilizer and pesticide input requirements [51].

In adapting to typhoon conditions, some farmers may choose to adopt improved coconut varieties, especially shorter trees that are less prone to damage from high winds. Early harvest of coconuts may also be needed in advance of typhoons, a practice dependent on the availability and access to weather forecasts. Like corn and rice farmers, coconut producers may choose to insure their production through the PCIC.

RICE

PROVISION OF SEEDS AND OTHER INPUTS

ON-FARM PRODUCTION

HARVESTING STORAGE AND PROCESSING

PRODUCT MARKETING

Hazard: DROUGHT

Consequences

- Reduces quality of seed
- Increases public/government expenditure
- Water stress and crop failure
- Pest and diseases outbreak
- Reduces total volume harvested hence income
- Low supply of milled rice
- Reduced supply of raw materials to rice processing complex
- Higher price of milled rice
- Low supply for final consumer

Underlying vulnerability factors/ sensitive groups

Socio-economic: short-term thinking, low level of partnership/association; **Institutional:** precarious access to basic services (potable water, medicines, food) and information, LGU with low budget relative to the population; **Infrastructure:** blockage of roads and bridges access

Adaptation options proposed

- Local biodiversity conservation (crops and wild species)
- Seeds buffer stocking
- Agro-forestry
- Access to financing
- Rainwater harvesting ($)
- Diversified farming (crops-livestock)
- Crop insurance
- Alley cropping
- Organic farming
- Soil fertility conservation technologies
- Farm mechanization
- Procurement of low-term buffer stock
- Incentive system (support/subsidies to organic products and inputs)
- Mobilizing multi-stakeholders (partnership and networking)
- Sourcing out of raw materials to other provinces to sustain market

Hazard: TYPHOON

Consequences

- Reduces quality of seed
- Defoliation/crop failure
- Higher production costs
- Damage of post harvest, storage and processing equipment
- Reduces product quality
- Wet palay

Underlying vulnerability factors/ sensitive groups

Biophysical: landlocked areas, soil erosion in hilly areas; **Socio-economic:** short-term thinking, high cost of transportation of farmers living in remote areas; **Institutional:** precary access to basic services (potable water, medicines, food) and information; **Infrastructure:** blockage of roads and bridges access

Adaptation options proposed

- Local biodiversity conservation (crops and wild species)
- Seeds buffer stocking
- Agro-forestry
- Access to financing
- Diversified farming (crops-livestock)
- Crop insurance
- Alley cropping
- Organic farming
- Soil fertility conservation technologies
- Farm mechanization
- Procurement of low-term buffer stock
- Incentive system (support/subsidies to organic products and inputs)
- Mobilizing multi-stakeholders (partnership and networking)
- Sourcing out of raw materials to other provinces to sustain market

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Magnitude of impact: Minor | Moderate | Major | Severe

Score priority: High | Medium | Low

Cost-Benefit Analysis: $ Available

COCONUT

PROVISION OF SEEDS AND OTHER INPUTS | ON-FARM PRODUCTION | HARVESTING STORAGE AND PROCESSING | PRODUCT MARKETING

Hazard: DROUGHT

Consequences

- High cost of nursery management
- Reduced quality of seeds
- Scarcity of seedlings
- Longer span for crop recovery after climatic impact
- Physiological problems e.g. coconuts not fully developed
- Decreases in production
- Decreases in production
- Higher time and labor cost for crop management and rehabilitation
- Damages in processing site and facilities
- Reduces total harvest
- Compromises the supply of raw materials
- Shorten the nuts storage life
- Less copra to buy from farmers

Underlying vulnerability factors/ sensitive groups

Biophysical: Farms far from rivers or other water sources farmers hence no or inconstant water supply; **Socio-economic:** farms with young coconut plants prone to drought and pest infestation, low access/registration to crop insurance services; **Institutional:** lack of participation/membership of any agricultural organization; **Infrastructure:** reduced row material supply

Adaptation options proposed

- Seed selection
- Water of seedling
- Crop insurance
- Integrated pest management (Bio-control)
- Sanitation
- Diversified farming (Coconut-Banana/ Coconut-Cacao) ($)
- Weather forecasting
- Livelihood diversification and value addition technologies

Hazard: TYPHOON

Consequences

- High cost of nursery management
- Low quality of seeds
- Scarcity of seedlings
- Decrease in production
- Plant site damage
- Less harvest
- Decline of supply
- Less copra to buy from farmers

Underlying vulnerability factors/ sensitive groups

Biophysical: farms located are in remote areas and or/ in hilly areas prone to landslides; **Socio-economic:** coconut is the only source of income (farmers and companies) implying low crop diversification and alternative livelihoods, low and/or unstable income, high cost of gasoline and lack of alternative energy sources which increase cost of transportation/operation, low access/registration to crop insurance services; **Institutional:** lack of participation/membership of any agricultural organization; **Infrastructure:** farms-to-market roads blockage due to landslides or damaged roads

Adaptation options proposed

- Use of improved varieties
- Use dwarf variety of coconut ($)
- Capacity building in integrated pest and diseases management
- Weather forecasting
- Livelihood diversification and value addition technologies
- Insurance systems
- Early harvesting
- Selling of whole nuts instead of copra
- Sold fallen coconut trees

Magnitude of impact: Minor | Moderate | Major | Severe

Score priority: High | Medium | Low

Cost-Benefit Analysis: $ Available

OFF-FARM SERVICES

Various off-farm adaptation support mechanisms in Visayas are provided to farmers by Local Government Units and government agencies like the Department of Agriculture, Agricultural Training Institute, Philippine Crop Insurance Company and the Philippine Coconut Authority. These organizations help farmers in responding to the adverse impact of climate change through trainings, workshops, livelihood support programs, financial assistance, crop insurance, farm demonstrations, infrastructure provision, equipment and machinery supply, and subsidies or cash incentives.

In Cebu, a workshop on community-based participatory action research on climate resilient agriculture under corn-based farming systems in Region VIII, for example, was conducted by the DA together with Visayas State University and the Municipal Agriculture Office (Daanbantayan). LGUs also host programs to help farmers secure microfinancing and to provide equipment like tractors for land preparation as well as corn mills for post-harvest activities. During trainings, farmers are encouraged to adopt no-tillage practices to minimize soil disruption and erosion. In Bohol province, meanwhile, various off-farm support mechanisms have been established through the DA Agricultural Promotion Center and the Agricultural Training Institute including rice technical demonstrations on featured farms, subsidies for the purchase of hybrid seeds, farmer field schools for rice intensification systems, and the conservation of plant genetic resources, among others. In Leyte, as a response to losses from Typhoon Haiyan, a replanting incentive program has been established where farmers are given cash incentives to replant coconut trees. A coconut fertilization project is also being promoted by the Provincial Coconut Authority (PCA), using agricultural grade salts and coir-based organic fertilizer, an approach that is acceptable to farmers given its cost effectiveness and environmentally-friendly nature. The Department of Agriculture also has seed stocks (corn, rice and coconut) ready for distribution to affected farmers in the case of extreme events or production losses. Weather forecasting services are also provided through Agromet Stations through LGUs, with text updates available to some farmers.

BARRIERS

The effective response of farmers to climate change and its associated hazards is often found to be hampered by a range of barriers, which either directly or indirectly limit their adaptive capacity. These barriers can be categorised as financial, technical, behavioural, informational and institutional. Figure 8 examines at the impact of each barrier category across the value chains analyzed in this report.

Rice farmers were found to lack sufficient information on climate change and its impacts, which, coupled with a lack of technical capacity to respond, leaves them especially vulnerable. Those farmers looking to adopt new techniques or resilient crop varieties often find themselves limited by financial constraints (e.g., access to credit) and inadequate buffer stocks. In times of drought or following a typhoon the prices of key inputs rise and supplies fall, exacerbating this situation. There is also a reluctance amongst farmers to adopt new practices. Institutional barriers include the failure of the government to provide sufficient compensation to farmers that attend their 'agri-schools' due to budget constraints, with farmers unable to afford the time away from the farm.

Corn farms located in remote, hilly areas have limited access to information, often relying on traditional methods in the absence of training on improved practices. Suppliers struggle to reach such remote regions and have little incentive to do so as farmers lack the financial capacity to purchase improved varieties and other inputs. Technical constraints exist for both on-farm production and processing due to a lack of experts to provide training to farmers and processors.

In the aftermath of major catastrophes such as typhoon Haiyan, coconut farmers lacked the financial capacity to clear their lands of debris before replanting. Many farmers participated in cooperative loans to help them re-establish their farms. Limited institutional capacities result in many farmers not receiving information on the spread of pests and diseases or training on improved practices. Farmers are, in some instances, reluctant to adopt new and improved practices, preferring to continue with traditional methods.

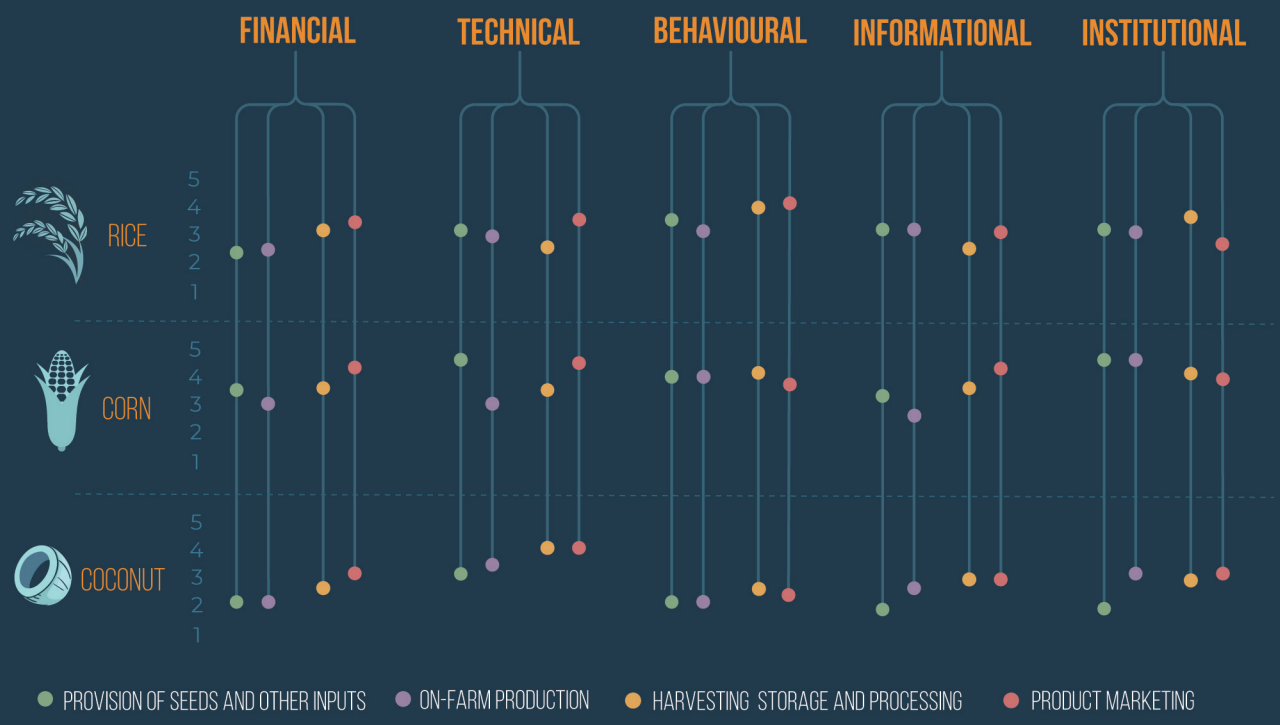

Figure 9: Maps the severity of different barriers across the VC of the key commodities. The height of the barrier corresponds to the severity on the left hand scale with 1 = no barrier and 5 = severe barrier.

POLICIES AND PROGRAMS

The Philippines has long-established laws aimed at promoting adaptation to climate change in the country. The Climate Change Act of 2009 (Republic Act No. 9729) mainstreams climate change into government policy formulations. Through this act, the Climate Change Commission (CCC) was created to serve as the sole policy-making body responsible for coordinating, monitoring, and evaluating climate change programs and action plans in the country. In order to ground this national level policy, LGUs subsequently crafted Local Climate Change Action Plans (LCCAP) for their respective communities, directly engaging barangays (the country's smallest administration units).

Amending the Climate Change Act, R.A. No. 10174 established the People's Survival Fund in 2012 to provide long-term financing for projects that address climate change. Its PHP $1 billion appropriation from the General Appropriations Act (GAA) is supplementary to any annual appropriations allocated by LGUs for Disaster Risk Reduction (DRR) and Climate Change Adaptation (CCA). Recognizing the close interrelation of DRR and CCA activities, R.A. No. 10174 mandated the integration of DRR activities into climate change programs and initiatives. The National Framework Strategy on Climate Change for 2010-2022, was introduced by the CCC, with an emphasis on adaptation.

The Philippines Nationally Determined Contribution (NDC), submitted to the UNFCCC in accordance with the Paris Agreement, stipulates the target of a 70% reduction in Greenhouse Gas (GHG) emissions by 2030 compared to the business as usual scenario. While adaptation is the focus of many policies due to the Philippines' high exposure to the impacts of climate change, there are a number of mitigation policies and initiatives. In 2014, President Benigno Aquino III signed Executive Order No. 174 to institutionalize the Philippine GHG inventory management and reporting system. This was created to enable the country's transition to a climate-resilient approach to sustainable development.

The Adaptation and Mitigation Initiative in Agriculture (AMIA), meanwhile, is the flagship program for climate change and mitigation within

the Department of Agriculture. The Department of Agriculture System-wide Climate Change Office (DA-SWCCO) oversees AMIA. Central to the AMIA initiative is the establishment of "AMIA Villages," where climate-smart best practices are showcased [52]. As part of this project, in Cebu, the provincial government with its provincial agriculture office introduced organic farming methods to their local farmers. The farmers were taught how to make fertilizer out of organic materials such as compost and fermented fish through a series of trainings. In Bohol, a rice program called Production, Marketing and Technology Enhancement of Organic Rice (PROMOTE-Rice) was implemented. The central components of this program were the creation of the Centre for Agribusiness and Sustainable Agriculture and training programs in organic agriculture, development of vermicast production, marketing facilities in six municipalities for producing and distributing affordable, high-quality organic fertilizer, and creation of the Balay sa Humay Rice Museum to promote organic rice production and attract tourists. In 2013, DA Secretary Proceso Alcala issued the memorandum, "Mainstreaming Climate Change in DA Programs, Plans and Budget", to further strengthen the implementation of R.A. No. 9729, particularly under the agriculture and fisheries sector. The Secretary likewise approved the Department's Seven-Wide Programs on Climate Change (DA-SWPCC) as follows: (1) Mainstream Climate Change Adaptation and Mitigation Initiatives in Agriculture; (2) Climate Information System; (3) Philippine Adaptation and Mitigation in Agriculture Knowledge Toolbox; (4) Climate-Smart Agriculture Infrastructure; (5) Financing and Risk Transfer Instruments on Climate Change; (6) Climate-Smart Agriculture and Fisheries Regulation; and (7) Climate-Smart Agriculture Extension System. In 2016, the program fund was linked to the Climate Change Program of the Bureau of Agricultural Research (BAR) to be used for R&D activities that are aligned with the AMIA framework with an emphasis on increasing the adaptive capacity and productivity potentials of agriculture and fisheries livelihoods.

The Agriculture and Fisheries Modernization Act (AFMA) aims to modernize the agriculture and fisheries sectors of the country and to enhance these sectors' profitability and preparedness related to the challenges of globalization. The AFMA has also led to the establishment of Strategic Agricultural and Fisheries Development Zones and the Agricultural and Fisheries Modernization Plan. Across these policies, the government prioritized access to credit to farmers and support for irrigation. However, given underinvestment in the sector, progress in these areas has been less than expected [53, 54].

Climate change is also captured in the country's overarching strategic framework for the Department of Agriculture, Agri-Pinoy (2011-2016). The strategy was built on four central themes: (1) food security and self-sufficiency; (2) sustainable agriculture and fisheries; (3) natural resource management; (4) and local development. The strategy calls for the coordination of regionally-based spatial planning, the provision of critical infrastructure needed by priority value chains, and the building of a more resilient production base to accommodate the variations in global markets and the effects of climate change [55]. The framework itself has various sub-programs, most notably the rice and corn programs.

The Philippine Coconut Authority region VIII implemented a project that could help address climate change, as well as to rehabilitate and recover the coconut sectors devastated by typhoon Haiyan. The Accelerated Coconut Planting and Replanting Program of the PCA has three main components: Participatory Coconut Planting Project (PCPP); Coconut Seedlings Dispersal Project (CSDP); and Indigenous People's Outreach Program (IPOP). The PCPP involves providing cash incentives to farmers who plant coconut trees. The CSDP involves distribution of high quality coconut seedlings to farmers and other organizations. The IPOP is a program that is designed to encourage indigenous people to participate in coconut planting. Coconut intercropping is also included in this program, which entails planting annual crops in unutilized spaces between coconut trees to address food security, especially after typhoons, and provide an additional source of income.

Philippine Rural Development Project (PRDP) is a six-year national project under the DA that aims to establish a modern, value-chain oriented, and climate-resilient agriculture and fisheries sector. The PRDP is a scaled-up version of the Mindanao Rural Development Program (MRDP) and is aligned with the Agri-Pinoy strategy. Through this project, value chains—including high value crops such as coffee and cacao—are prioritized for investment and development. The "I-PLAN" component of PRDP assists LGUs in the development of Provincial Commodity Investment Plans that serve as blueprints for investment in priority commodities. The "I-BUILD" component of PRDP then puts in place strategic and

climate-resilient rural infrastructure facilities along these value chains, including farm-to-market roads, communal irrigation systems, potable water supplies, and postharvest and other rural infrastructure.

GOVERNANCE AND INSTITUTIONAL RESOURCES AND CAPACITY

The government institutions active on climate change issues include the Climate Change Commission (CCC), Department of Agriculture and related agencies, such as the Philippine Atmospheric, Geophysical and Astronomical Services Administration and local government units. The CCC is responsible for coordinating, monitoring, and evaluating programs and actions on climate change by the government. The Department of Agriculture is mandated to promote agricultural development by providing public investments, policy frameworks, and services needed for domestic and export-oriented agricultural business enterprises. Through its offices in the regional, provincial, and city level, the DA is pivotal in implementing new technologies, practices, and other services that may impact farmers or agricultural value chain actors in the country. The Department has attached bureaus and agencies—like the Agricultural Training Institute or the Bureau of Agricultural Research— tasked with implementing climate change-related programs, conducting research, providing trainings and offering extension services. The Systems-Wide Climate Change Office, meanwhile, coordinates and manages AMIA, the flagship program for climate adaptation and mitigation of the DA.

LGUs also play a central role in mainstreaming climate change adaptation in the country, as evidenced by their development and implementation of Local Climate Change Action Plans. LGUs consist of various sub-national administrative units including the region, province, city, municipality, and the barangay. According to the Local Government Code of the Philippines, the barangay acts as the primary implementing unit of government policies, plans, programs, projects, and activities. Municipalities also coordinate and deliver primary services within their territorial jurisdictions. The province serves as a dynamic mechanism for developmental processes and effective governance of other LGUs within its territorial jurisdiction. The Provincial Agriculturist's Office is mandated to promote sustainable agriculture and enhance the growth of fisheries through increased productivity and profitability, coordinating DA projects and programs. The office employs coordinators for every crop grown in the province, reaching specific farmers with specially tailored services.

EXTENSION

The DA, through the Agricultural Training Institute, is the agency charged with delivery of extension services for the agriculture and fisheries sectors, providing training to agricultural extension workers. Apart from ATI, DA offices in LGUs also conduct ad-hoc trainings for farmers. The Municipal Agriculture Office, for example, conducts trainings on nursery establishment, crop production, and post-harvest practices. NGOs and private entities or companies like CIDAMI often have more resources to provide extension services to farmers and often do so through seminars.

RESEARCH AND DEVELOPMENT

The Department of Science and Technology (DOST), Department of Environment and Natural Resources, and the DA through the Bureau of Agricultural Research are among the institutions that provide research and development support to the agricultural sector in the Philippines. In addition, individual academics also play a key role in research and development related to climate change and climate-smart agriculture. Under DOST, the Philippine Council for Agricultural Resources, Research, and Development have a number of researchers working on these topics. Through the BAR, spending on agricultural research for national programs on rice, corn, and high value crops has grown substantially in recent years. Still, the research system of the country remains fragmented and lacks synergy among institutions in terms of identifying shared research priorities [56].

FINANCE

There are also various financial institutions in the Philippines that provide support for climate change adaptation. The Philippine Crop Insurance Corporation, for example, is a DA-affiliated agency that provides insurance protection for corn, rice and other crops against losses resulting from natural disasters, pest infestations, or plant diseases. Coverage typically protects farmers for up to 120% of the cost of production inputs. Not all farmers are able to access insurance, however, given that they are not properly enrolled in the Registry System for Basic Sectors in Agriculture, while others are simply unaware of its existence entirely.

The Land Bank of the Philippines is also a formal provider of financial services to the agricultural sector. Through its Agricultural Credit Support Project and Agrarian Production Credit Program (APCP), the bank is able to provide loans and financing to farmers. APCP is a joint credit program with the Department of Agrarian Reform to provide financing to newly-organized Agrarian Reform Beneficiary Organizations and to farmer organizations that would traditionally be ineligible to access loans from commercial banks. Another government-owned bank that provides financial support to farmers is the Development Bank of the Philippines. The bank has a Seed High Value Crops Financing Programs with an interest rate of 10-12% but requires Securities and Exchange Commission and Cooperative Development Authority registration with land title and other business documents. Commercial and private banks can be a source of financial services to farmers although private banks often have a number of other conditions that are difficult for farmers to comply with, including higher collateral requirements.

The Agricultural Credit Policy Council (ACPC) assists the DA in synchronizing all credit policies and programs in support of the DA's priority programs. Under ACPC is the Climate Change Adaptation Financing Program (CCAFP), a special financing under the Agriculture and Fisheries Financing Program that aims to encourage small farmers and fisherfolk (SFF) to adopt climate change adaptation practices and technologies. It aims to help agricultural households adapt to the adverse effects of climate change through the provision of loans for climate-resilient practices and technologies.

Another program under ACPC is the Production Loan Easy Access program, a special credit facility of the Unified Lending to Agriculture program. Eligible borrowers are marginal farmers or fishers engaged in agri-fishery production. Two to ten year loans are provided up to PHP $50,000, subject to the project requirements and repayment capacity of the borrower as evaluated by the lending agent.

Finally, as determined by the DC and ACPC, the Survival and Recovery (SURE) assistance program can be mobilized to serve as a fast-response, post-disaster support facility, providing grants and loans to calamity-affected small farmers and fisherfolk and their households. SURE has initial funding of PHP $100 million with a further PHP $1 billion committed by the President.

SYNTHESIS AND OUTLOOK

Agriculture plays a major role in the economy and society of Visayas, yet the sector faces considerable threats from the impacts of climate change. Climate hazards in the form of droughts and typhoons pose a significant threat to rice, corn, and coconut production in Visayas. The disruption caused by such events are felt across the entire value chain from the provision of seeds and inputs to product marketing.

Unpredictable weather in Visayas has produced uncertainty and delays in critical farm activities, including the distribution of seeds and inputs. On farm, intense heat forces farmers and laborers to work fewer hours in fields, affecting production. The powerful Typhoon Haiyan in 2013 demonstrates the devastating impact of tropical storms on farmers in Visayas, destroying livelihoods and production and post-harvest infrastructure.

These and other impacts will continue to shape the future of agriculture in the region. The high costs of rehabilitation after extreme events are incurred by both private actors and the government since these institutions are responsible for safeguarding the agricultural sector against such hazards. During harvest periods, drought and typhoon can affect the quality of produce given interrupted processing or drying and increase the costs of labor and processing.

Various adaptation options were identified by value chain stakeholders in Visayas. In addition to a host of on-farm strategies like integrated crop-livestock systems and diversification, to protect against both typhoon and drought, farmers across value chains identify the need to protect their harvests with crop insurance provided through the Philippines Crop Insurance Corporation (PCIC). Improved access to credit for farmers with limited financial capital is another high-level strategy required by many, allowing producers to access improved inputs like drought, heat and flood tolerant crop varieties.

Communicating the benefits and effectiveness of adaptation strategies to traditional or difficult-to-reach farmers is a significant barrier to adaptation. Limited manpower availability, sometimes due to disincentives created by government safety net programs, also limits adoption of labor intensive adaptation measures and negatively impacts harvest periods. A lack of financial resources also plagues farmers and limits adaptation.

To overcome these challenges, government and private sector actors should work to ensure that farmers, sometimes in distant places, are able to organize themselves into farmer-based organizations to ensure improved access to inputs and credit and to facilitate improved market rates (perhaps combined with ordinances to ensure price premiums for organic production). Given the vulnerable to extreme events, the Philippine Atmospheric Geophysical and Astronomical Services Administration, weather stations, LGUs, and NDRRMC are responsible for providing weather advisories. These text advisory services should be expanded to offer early warning for prolonged droughts and for long drought rainy periods.

Ultimately, a host of actors, from government to civil society to the private sector, must work together to support value chain actors in Visayas to adapt to the impacts of climate change. These measures will have generous returns on poverty alleviation and in ensuring the future of a sector so critical to livelihoods and the regional economy.

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Main authors: James Giles, Paula Beatrice Macandog, Chase Sova, Moises Neil V. Seriño, Jessa H. Ruales, Wendy C. Enerlan, Leo Kris Palao, Jane Girly Balanza, Jack Hildebrand, and Godefroy Grosjean
Project leader for Asia: Godefroy Grosjean (CIAT)
Original graphics: Fernanda Rubiano (independent consultant)
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Barangay Agricultural Extension Worker (BAEW)

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