

CLIMATE CHANGE RDEAP

Research and Development and Extension Agenda and Program
for Agriculture and Fisheries

2016 - 2022



CLIMATE CHANGE

RESEARCH AND DEVELOPMENT AND EXTENSION (RDE)
AGENDA AND PROGRAM FOR AGRICULTURE AND FISHERIES

2016 - 2022

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CHANGE

INTRODUCTION



Recognizing the urgent need to address the challenges and threats of climate change to the agricultural productivity and livelihood, the Department of Agriculture - Bureau of Agricultural Research (DA-BAR), in collaboration with DA agencies, academe, and other partner institutions, formulated the **Climate Change Research and Development and Extension Agenda and Program (CC RDEAP) for Agriculture and Fisheries** in 2011. This agenda, consistent with DA-Systems Wide Climate Change Program (DA-SWCCP) are anchored on two pillars: adaptation and mitigation, with adaptation as the anchor strategy and mitigation as a function of adaptation. The growing awareness and collective response of

our partners to this effort paved way for the refinement of the Research and Development and Extension (RDE) directions and priorities for the agriculture sector.

Since 2011, the bureau has supported 25 climate change-related projects, of which twelve (12) have been completed (Table 1). Most have dealt with vulnerability and risk assessment of agriculture and fisheries productions, including the socio-economic analysis and projection of the future climate change impacts based on the simulation of existing data and pattern of different climate elements. Some conducted documentation and analysis of the adaptive strategies and practices employed



Table 1. Completed climate change-related R&D projects supported by DA-BAR, 2011-2015.

Project Title	Implementing Agency
Assessment of the impacts of extreme and erratic weather condition in the rice terraces of the Cordillera Region	Ifugao State University
Assessment of the direct and indirect effects of climatic changes in local dairy production	University of the Philippines Los Baños
Risk of rice tungro epidemics under climate change in the Philippines	University of the Philippines Los Baños
Vulnerability of the Philippine Mallard duck (<i>Anas platyrhynchos</i> Linn.) egg production to changes in temperature and relative humidity	University of the Philippines Los Baños
Selection/breeding of known drought-resistant, pest/disease resistant and flood-tolerant species for climate change adaptation	University of the Philippines Los Baños
Modelling and forecasting leaf blight epidemics in white corn under climate change	University of the Philippines Los Baños
Economic analysis of climate change adaptation strategies in selected coastal areas in the Philippines	University of the Philippines Los Baños
Socio-economic aspects on the vulnerability, risks and adaptation on major rood crops (corn, durian and banana) towards climate change effects in Regions XI and XII, Philippines	WorldFish Center
Strategic risk analysis of long-term climate variability in Jomalig and Polilio Islands in Quezon Province	University of Southern Mindanao
Climate change adaptation strategies for agriculture in community watersheds of Cagayan River Basin	Isabela State University
Aerobic rice production system: Improving productivity in water scarce areas of Cagayan Valley	Isabela State University
Sea Water and Farm Resources Management (SEAFARM) for increased corn and peanut productivity	University of the Philippines Los Baños Foundation, Inc.

by farmers in coping with the adverse effects of climate change. There was also a project on the development of climate-resilient crop production systems that included selection/ breeding of crop varieties tolerant to adverse climatic conditions and establishment of sustainable farming practices and technologies.

Climate change is here. Its pervasive effects, particularly on the agriculture and fishery resource base, continue to pose grave threats to the livelihood of rural communities as well as to the country’s food security. Given this context, the need to further enhance the agenda has become more imperative. Through a series of multi-stakeholder consultative

and participative meetings and discussions, the **CC RDEAP 2016-2022** was developed. This publication is envisioned to be a reference document of the bureau and its implementing partners in prioritizing RDE activities for the next medium term.

The **CC RDEAP 2016-2022** highlights three major components: **Program Logical Framework**, a common framework as basis for a wider inter-agency collaboration and enhancement of various methodologies and approaches that would harmonize efforts towards addressing climate change; a more comprehensive **Sectoral RDE Agenda**, formulated and consolidated together with partner implementing institutions

and anchored on a better organizational and institutional arrangements to promote partnership, work facilitation and sharing of information; and, **Mainstreaming Checklist for**

RDE Proposals, a mechanism in mainstreaming climate change concerns in various phases of RDE program and project planning and implementation.



Program Logical Framework

Anchored on Sustainable Development Goal 2 and Goal 13 of the United Nations (UN) Agenda 2030, the Climate Change Program Logical Framework aspires to help contribute to food security by minimizing the effects of climate change on the productivity and income of farmers and fishers while maintaining the long-term sustainability of the agriculture and fishery resource base. The logical framework in itself is already a reference document defining clear development objectives, outcomes and indicators hence, supporting a more effective program planning, implementation, and evaluation. Given all the risks and uncertainties that the agriculture and fishery (A/F) sector experiences due to the changing climate, the need to translate research outputs into useful forms enabling policy makers to make informed decisions, becomes more important. The three outcomes indicated in the Logical Framework

fully support the Climate Change Commission's (CCC) call for "science to include both improving understanding and informing and supporting decision-making." Moreover, the portfolio of outputs and researchable areas of the CC RDEAP 2016-2022 are aligned with and further fleshed out the identified R&D directions and priorities of the Food Security Component of the CCC R&D Agenda 2011-2028.



Sectoral RDE Agenda

Sustainable and resilient agricultural practices from production to consumption stage must be pursued from a holistic and integrated perspective. Hence, certain enhancements can be found with the Sectoral RDE Agenda. First, it adopted the value-chain structure, it has also incorporated challenges, concerns, and researchable areas pertaining to policies and governance. Lastly, the Sectoral RDE Agenda explicitly identified tangible expected outputs.

The updated agenda have a more comprehensive perspective as the different problems and researchable areas for all the stages of the value chain have been identified. It is recognized that the agriculture and fishery sector is composed of a network of actors and interlinked activities and services. In looking and studying the whole value chain, areas of improvement can be explored for better productivity, efficiency, profitability, inclusiveness and competitive advantage at each level.

There is an unequivocal need for research results to be translated into information useful to policy and decision makers. The role and responsibility of the government is primarily on policy formulation, implementation, and provision of an environment conducive to all the stakeholders concerned. However, this function is not and should not be in isolation as policy decisions need to be based on the best evidences possible. Hence, scientific and technical inputs from researches contribute to clarity and better understanding of the full range of social, institutional, legal, economic, and environmental contexts the agriculture and fishery sector as a whole operates in.

The Sectoral RDE Agenda include tangible expected outputs to help verify the actual achievement of each of the researchable areas and to support the entire process of managing for results at every stage of the value chain.



Mainstreaming Checklist for R&D Proposals

Pursuant to the provision of the Climate Change Act of 2009 (RA 9729), DA issued a memorandum in 2013 enjoining all its operating units to mainstream climate change in the department's programs, plans and budget. Specifically, it states that government to "mainstream climate change in the various phases of policy formulation, such that policies and measures that address climate change are integrated in development planning and sectoral decision making."

In compliance with the law, and the need for a solid foundation to ensure that climate change concerns are mainstreamed in the operations of DA-BAR, the Mainstreaming Checklist for R&D Proposals was formulated. This is institutionalized within the bureau's operation starting in 2016. The checklist will help the bureau in prioritizing the R&D proposals by understanding the following:

- climate change hazard/risk proposed to be addressed;
- climate change risks on the target beneficiaries, project area and the value chain activities/stages;
- level of participation of the target beneficiaries - in support to increased climate change advocacy, social mobility and equality to encourage ownership of the technology and ensure sustainability of the adoption of technology; and
- level of participation and support of other organizations (i.e. development organizations, academic or scientific community, local authorities, private sector) which would result to increased awareness, greater synergy and sustainability that goes beyond the R&D project implementation.

As the UN Agenda 2030 calls forth all member states to develop ambitious national responses by formulating planning instruments and national and sustainable development strategies, the CC RDEAP 2016-2022, a composite of three reference documents grounded on a common goal, may be considered as one of the bureau's transformative and catalytic steps to help shift the agriculture and fisheries sector towards a sustainable and resilient industry.



CLIMATE CHANGE

R&D PROGRAM LOGICAL FRAMEWORK

Goal
Ensure food security by minimizing the effects of climate change on the productivity and income of farmers and fishers while maintaining the long-term sustainability of the agriculture and fishery resource base.

Development Objective
An integrated agriculture and fishery research and development program that builds and enhances the national and local capacities to minimize risks and reduce the vulnerability of rural communities to variable and changing climate.

Narrative Summary	Performance Indicators	Means of Verification	Assumptions
Outcome 1. Increased understanding and knowledge to address the threats and impacts of climate variability on agricultural production and food systems.			
<i>Output 1.1</i> Crop improvement and animal/ fishery breeding strategies to address biotic and abiotic stresses induced by variable and extreme climate conditions developed and established.	a. Research designs and modeling approaches to assess impacts of changing climate and effects of new technologies on at least two priority crops, livestock, and fisheries prepared and adopted b. Climate resilient varieties and breeds tested and evaluated for efficacy c. Commodity development or strategic plan to ensure long-term productivity prepared/ established	project documents/ reports; commodity road maps/ development plans	a. Government priorities in terms of commodities and research activities remain valid and supported under the medium/long term agriculture/fisheries sector plan b. Collaboration/ implementing modalities with partner institutions/ RDE networks are further enhanced. c. Sustained support to various research programs under RDEAP
<i>Output 1.2</i> Adaptive production and post-production options covering practices (planting strategies, pest and disease management, diversification, etc.) and technologies (seed varieties, irrigation techniques, etc.) that are climate change compliant identified and developed.	a. Methodologies/ framework for assessing impact of technologies covering potential application domain, cost and return, and institutional arrangements to support adaptation developed and adopted b. Decision tools and guidelines to support the selection of most appropriate technology and practices and required processes for these options to function prepared and disseminated	research papers/ journals; project completion reports; annual reports	d. Regional agricultural/ fisheries development plan prepared/research and development priorities defined e. Sustained/enhanced support to SUCs/RDE networks in terms of manpower development and facilities upgrading

Narrative Summary	Performance Indicators	Means of Verification	Assumptions
<p><i>Output 1.3</i> Implementation measures and procedures that enhance the conservation and utilization of threatened species and cultural diversity for increased resilience and productivity issued and disseminated.</p>	<p>a. Accessions identified for priority crops, livestock, fisheries, and animals with potential traits/ characteristics that are resilient to climate change</p> <p>b. Appropriate systems/ procedure to enhance conservation of species and genetic diversity and facilitate integration into production system and field deployment developed and implemented</p>	<p>research papers/ journals; project completion reports; annual reports</p>	<p>a. Government priorities in terms of commodities and research activities remain valid and supported under the medium/long term agriculture/fisheries sector plan</p> <p>b. Collaboration/ implementing modalities with partner institutions/ RDE networks are further enhanced.</p>
<p><i>Output 1.4</i> Location-specific studies in the identified major production areas which are considered vulnerable to climate change completed.</p>	<p>a. Appropriate methodologies/ tools in risk/ vulnerability assessment of major agriculture/ fishery production areas developed and disseminated</p> <p>b. Detailed report/study to include action plan integrating various technology options, practices, institutional set-up and needed local/national policies and regulations completed and adopted.</p>	<p>research papers/ journals; project completion reports; case studies</p>	<p>c. Sustained support to various research programs under RDEAP</p> <p>d. Regional agricultural/ fisheries development plan prepared/research and development priorities defined</p> <p>e. Sustained/enhanced support to SUCs/RDE networks in terms of manpower development and facilities upgrading</p>
<p><i>Output 1.5</i> Improved design standards/ specifications of various agriculture and fishery infrastructure and other support facilities as well as updated construction protocols and methodologies to make them climate resilient developed and disseminated.</p>	<p>a. Technical review/evaluation of various equipment, facilities and infrastructures covering production, post-production to include processing, transport and storage completed. Specific technical and socio-economic issues and problems identified/ addressed</p> <p>b. Technical recommendations discussed and validated for incorporation in the proposed revised standards</p>	<p>research papers/ journals; project completion reports; technical manual/ guidelines</p>	

Narrative Summary	Performance Indicators	Means of Verification	Assumptions
Output 1.6 Assessment and analysis on the technical and economic impact of climate change on the supply chain and other activities in the food system of major agricultural and fishery products completed.	<p>a. Commodity-specific studies on the impact of climate change covering socio-economic aspects (price, product/food quality and safety, etc.) and requirements for processing, storage and distribution completed, discussed and disseminated</p> <p>b. New /revised product standards and protocols for processing, storage and other activities within the food systems prepared and adopted</p>	research papers/journals; project completion reports; case studies; technical manuals	<p>a. Government priorities in terms of commodities and research activities remain valid and supported under the medium/long term agriculture/fisheries sector plan</p> <p>b. Collaboration/ implementing modalities with partner institutions/ RDE networks are further enhanced.</p> <p>c. Sustained support to various research programs under RDEAP</p> <p>d. Regional agricultural/ fisheries development plan prepared/research and development priorities defined</p> <p>e. Sustained/enhanced support to SUCs/RDE networks in terms of manpower development and facilities upgrading</p>
Outcome 2. Farm to community-based climate risk management practices and off-farm opportunities implemented in suitable agro-ecological systems or benchmark locations.			
Output 2.1 Adaptive production and post-production technologies/ options and off-farm opportunities demonstrated in pilot areas within the agro-ecological zones.	<p>a. Action plan in the identified/ selected areas to showcase promising/proven innovations to manage risks at field/local level prepared and adopted by local communities and executives</p> <p>b. Increased number of farmers/ members of the community in the project/expansion of the project coverage within the recommendation domain</p>	project completion reports; annual reports; agency/LGU websites	<p>a. Municipal/provincial LGUs are willing and interested and capable to participate</p> <p>b. Partner SUCs in the countryside have the minimum resources and expertise to participate</p>

Narrative Summary	Performance Indicators	Means of Verification	Assumptions
<p><i>Output 2.2</i> Current practices, actions, and tools employed by farmers and fishers for managing risks documented and synthesized.</p>	<p>a. Methodologies/tools to assess/ evaluate farmers’ strategies and best practices in managing risks developed.</p> <p>b. Documentation and analysis of the current best practices and processes of institutional learning and adaptation</p> <p>c. Synthesis of findings on farmers and fishers coping mechanisms</p>	<p>project completion reports; annual reports; agency/LGU websites</p>	<p>c. Farmers/farmers’ associations have shown interest to the proposed innovations and are willing participate in the program/ project</p> <p>d. Sustained implementation of the bureau’s banner programs (i.e. CPAR, NTCP etc.)</p>
<p><i>Output 2.3</i> Localized decision support system (i.e. information, methodologies, and platforms) available for improved climate prediction developed.</p>	<p>a. Models/methodologies and platform for monitoring, predicting and forecasting yield/ production as well as biological threats as brought about by climate change (i.e. climate-sensitive pest and disease modelling, commodity-climate simulation models, probabilistic climate/weather forecasting models, production and yield forecasting techniques, early warning systems etc.)</p> <p>b. Down-scaled historical meteorological data sets (combining PAGASA, other station observations and satellite data) for modelling/ forecasting and local agricultural decision-making purposes made available to farmers and other stakeholders.</p>	<p>project completion reports; manuals/ documentary reports; agency websites</p>	<p>e. Government/DA acquired satellite data/ images as well as historical meteorological database are made available for the purpose.</p> <p>f. Global models on various climate information services are available for purposes of downscaling for local adaptation.</p> <p>g. DA-wide knowledge sharing platform is in place and fully operational.</p> <p>h. Historical meteorological data from DOST-PAGASA and other sources are available and readily accessible.</p>

Narrative Summary	Performance Indicators	Means of Verification	Assumptions
<p>Output 2.4 Safety nets, crisis and post-crisis response mechanisms developed in benchmark locations.</p>	<p>a. Review and assessment of various models of index-based risk transfer products/insurance mechanisms (global and local)</p> <p>b. Business models developed and implemented in benchmark areas</p> <p>c. Innovative financing schemes (microfinance, savings, subsidies, etc.) and risk management portfolios to support farmer's recovery efforts developed and piloted</p>	<p>project completion reports; agency/LGU website</p>	<p>a. Municipal/provincial LGUs are willing and interested and capable to participate</p> <p>b. Partner SUCs in the countryside have the minimum resources and expertise to participate</p> <p>c. Farmers/farmers' associations have shown interest to the proposed innovations and are willing participate in the program/ project</p> <p>d. Sustained implementation of the bureau's banner programs (i.e. CPAR, NTCP etc.)</p> <p>e. Government/DA acquired satellite data/ images as well as historical meteorological database are made available for the purpose.</p> <p>f. Global models on various climate information services are available for purposes of downscaling for local adaptation.</p> <p>g. DA-wide knowledge sharing platform is in place and fully operational.</p> <p>h. Historical meteorological data from DOST-PAGASA and other sources are available and readily accessible.</p>

Narrative Summary	Performance Indicators	Means of Verification	Assumptions
Outcome 3. Integration and mainstreaming of appropriate and relevant technologies (i.e. approaches, frameworks, methodologies, tools, strategies) and information into planning/policy formulation and wide-scale implementation.			
<i>Output 3.1</i> Climate-related data, vulnerability information/maps/ GIS, outputs of various researches, and other databases are integrated into an agriculture and fisheries climate risk information systems to promote climate resilient planning and investment decisions.	<p>a. Risk assessment information, vulnerability maps and other climate-related information developed</p> <p>b. Knowledge/information sharing platform to facilitate exchange of data and experiences and promote joint cooperation and collaboration established</p>	DA, DA-BAR, DA-BSWM, other agency websites; project completion reports	<p>a. DA strategic maps/ databases are accessible/ available for the purpose. DA-wide knowledge sharing/web platform is in place and accessible.</p> <p>b. Program/project monitoring and evaluation system is further enhanced.</p>
<i>Output 3.2</i> Integrated models, frameworks, and system to monitor and evaluate the progress and likely impact of adaptation mitigation options and other interventions within the food system developed.	<p>a. Ex-post impact assessment conducted to identify knowledge gaps, feasibility and replicability of the adaptation and mitigation options for wider-scale implementation</p> <p>b. Refined ex-ante evaluation system and decision tools to aid in prioritizing research projects and activities</p>	projects progress/ regular reports and project completion/ terminal reports; agency Annual reports; manuals/ guidelines for implementation	
<i>Output 3.3</i> Comprehensive analysis and recommendations on enhancing and harmonizing existing policies, plans, and programs initiated.	<p>a. Policy inputs and recommendations covering urgent/priority issues and concerns prepared and discussed</p> <p>b. Policy dialogues/ public consultations/forum conducted where specific policy issues and concerns are discussed</p> <p>c. Redefined agriculture and fisheries development planning framework incorporating factors/ variables associated with climate change prepared and regularly updated</p>	project completion reports; policy papers; planning/project development and evaluation guidelines	





CROPS

CLIMATE CHANGE RDE AGENDA 2016-2022

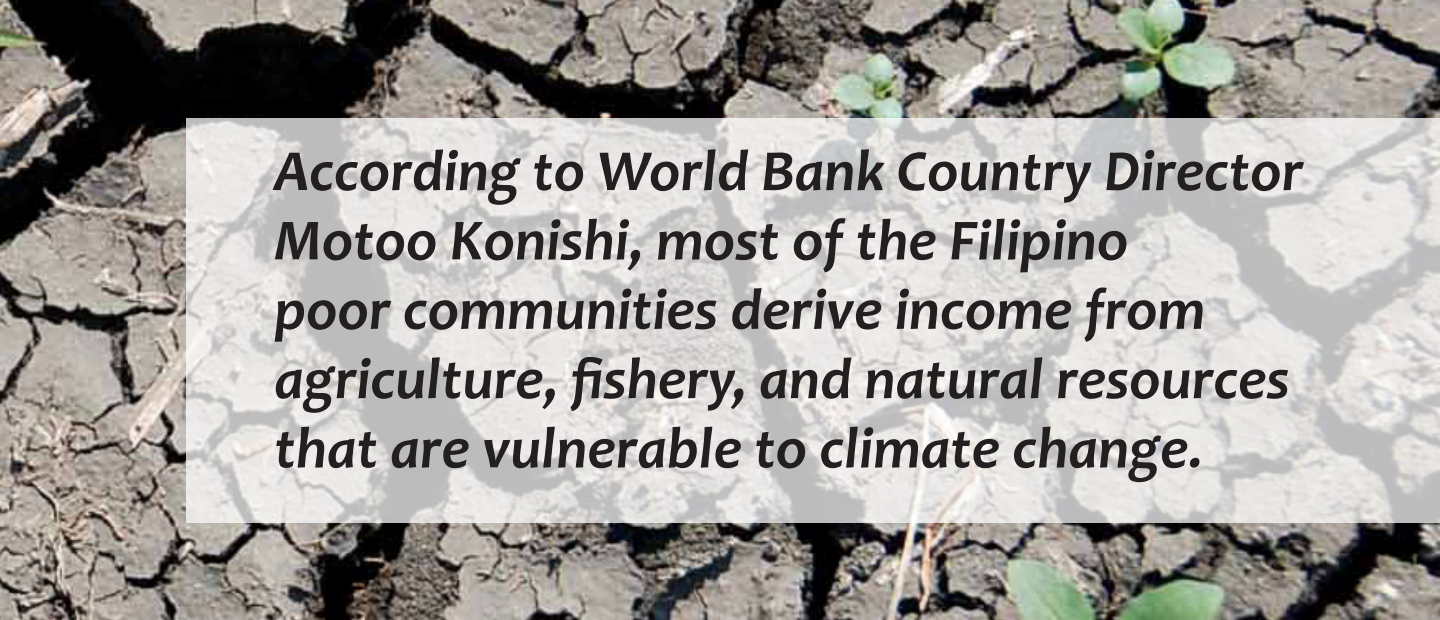
The total population of the world is projected to reach around 8.9 billion by 2050 (United Nations, 2004). Feeding these billions of people will prove to be a challenge especially in times of extreme changing climate conditions. Sajise et al., (2010) stressed that there will be countries that will have least capacity to cope with drastic changes and thus, affecting their ability to grow food and generate other food needs. The projected impacts will vary over time and across locations and there will be significant losses of genetic resources especially on crop species and the less mobile and less tolerant animals. Using different models, Sajise et al. (2010) projected that there will be 23 crops that will suffer significant decreases in the suitable areas for growth including strawberry, wheat, rye, apple, and oats, to name a few. Also, there are 20 crops projected to gain more favorable areas for growth like pearl millet, sunflower, common millet, chickpea, and soyabean. With the changes in suitable areas for growth, modifications in the consumer's food preferences will be created as well. There is a need to broaden the currently very narrow food base by exploring underutilized food species. Intensified collection, characterization, conservation, and utilization of neglected species are also being looked into.



The Philippines, a nation with an economy that is highly-dependent on agriculture, is projected to reach 141.7 million by the year 2040, in a recent report from the National Statistical Coordination Board (NSCB). According to World Bank Country Director Motoo Konishi, most of the Filipino poor communities derive income from agriculture, fishery, and natural resources that are vulnerable to climate change. (World Bank, 2013) The agriculture sector employs

about one-third of the total employment of the country and contributed about 18 percent to gross domestic product. (CCC, 2010) The sector also harbors a large proportion of damages due to climate related events every year. Data showed that from 1990 to 2006, there is a P12.43 billion average annual values of damages to agriculture, 70.3 percent were caused by typhoons, 17.9 percent by drought and 5 percent by floods (CCC, 2010). From 1980 to 2010 data, damages to agriculture caused by typhoons during the typhoon months, July - December, reached as high as P5.9 billion average annually (CCC, 2010).

There were observed anomalies in the temperature, rainfall and extreme weather



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events of the country for the past few years. Ancog et al., (2012) observed that the frequency of hot days and warm nights have increased while the number of cold days and cool nights have decreased. There were departures from the annual mean, maximum, and minimum temperatures in recent years of 0.61°C , 0.34°C , and 0.89°C , respectively from 1961 to 1990 normal values. There is also an observed increase in the mean annual rainfall and number of rainy days in the country. Data also showed that the intensity of rainfall is increasing in Baguio, Tacloban, and Iloilo, increasing rainfall frequency in Calapan, Laoag, Iloilo, and Tacloban while a significant decreasing trend was observed in Palawan (Ancog and et al 2012). The

frequency of typhoons entering Philippine Area of Responsibility significantly increased from 1993 to 2003 with most passing over the Central Visayas region. It was also during the past 15 years that the Philippines was hit by the strongest typhoon ever recorded, the most destructive, the deadliest, and that registered the highest recorded 24-hour rainfall (Ancog and et al 2012).

The effect of climate change will vary by crop, location, and magnitude of drought, flood and concentration of CO_2 . Adams et al., (1998) reported that increasing the temperature, holding other factors constant, decreases crop yields while increases in





precipitation lessen or offset this result. Increasing concentration of CO₂ on crop yields on the other hand, significantly raises the yield of many crops. They added that economic consequences of any yield changes will be influenced by adaptations made by farmers, consumers, government agencies, and other institutions.

Lansigan and Salvacion (2007) assessed the effect of climate change on rice and corn yields in selected provinces of the Philippines and established the fact that an increase in CO₂ level increases the yield, while increase in temperature reduces the yield (Table 2 and 3). They attributed the increase in yield to

the increase in photosynthesis resulting from higher CO₂ concentration. However, there was a distinction in the response of crops to climate change stresses which can be attributed to the difference in the photosynthetic pathways for carbon assimilation. Rice uses the C₃ pathway while the corn uses the C₄. C₃ crops like wheat, rice, and soybeans respond more to CO₂ enrichment than the C₄ crops like maize, sorghum, and sugarcane (Lansigan and Salvacion, 2007). Furthermore, simulation results of the study indicated that corn performed better than rice under potential climate change. Also, the impact and effect of climate change varies on the time/stage the crop is exposed to the stress.

Table 2. Rice yield reduction coefficients due to drought.

Period of Stress	% Yield Loss
Early vegetative stage (transplanting to tillering)	30-50
Early vegetative stage to reproductive stage (transplanting to panicle initiation)	60-75
Early vegetative stage to reproductive stage (transplanting to heading)	65-70
Maximum vegetative to reproductive stage (maximum tillering to heading)	45-50
Reproductive to maturity stage (panicle to maturity)	60-100
Reproductive to maturity stage (booting to maturity)	60-100
Reproductive to maturity stage (flowering to maturity)	60-100
Late reproductive to maturity stage (milking to maturity)	45-60
Maturity stage soft dough to maturity (hard dough to maturity)	10 or less
Transplanting to maturity stage (minimum tillering to maturity)	95-100

Source: Lansigan, LGU Summit +31 presentation



Table 3. Estimated rice yield loss due to typhoon-induced strong wind.

Crop Growth Stage	Wind Velocity (kph)					
	7 - 100		101 - 150		>150	
	Period of Exposure (hrs)					
	< or = 12	>12	< or = 12	>12	< or = 12	>12
	Estimated Yield Loss (%)					
Booting	<10-15	15-20	15-25	20-30	15-30	25-35
Flowering	10-25	25-30	15-30	30-35	25-40	35-50
Maturity	<10-15	15-20	10-20	20-25	15-25	25-30

Source: Lansigan, LGU Summit +31 presentation

Previous studies have focused only on few commodities, but there are still a lot of information gaps in the effects and impacts of climate change in the different crop species. The country still needs to pursue other studies on other major agricultural crops. Studies on

how different crops respond to stresses like elevated CO₂ level and increased temperature or the combined effects of the two should be explored, hand in hand with how best these effects and impacts can be addressed or mitigated.



Problems	Researchable Areas	Expected Outputs	Possible Implementing Agencies	Timeline
Pre-production				
Rising temperatures and shifting precipitation patterns alter the crop-water availability and crop productivity	Development of unified Vulnerability Suitability Assessment (VSA) for all areas	Recommended VSA procedures for specific area	National/Regional/SUCs	2016-2017
	Development of a dynamic location-specific planting calendar based on seasonal climate outlook	Information on crop specific optimal planting period for a specific location	National/Regional/SUCs/LGUs	2016-2018
		Cropping calendar given downscale seasonal climate outlook	National/Regional/SUCs/LGUs	2016-2018
	Inventory of available seeds/planting materials (stress tolerant and resilient crops)	Information on available seeds/planting materials (any crop) that are stress tolerant and resilient and where to source them out	National/Regional/SUCs/LGUs/BPI/Philrice/PCA	2016-2018
Production				
Decreased agricultural productivity due to different biotic and abiotic stresses	Development of crop modelling tools (crop stress monitoring, crop yield forecasting) for predictive use especially for high value crops	Decision support tools, crop forecasting systems, forecast models, crop-climate simulation models	National/Regional/SUCs/BPI/ITCAF/International Agencies	2016-2022
Seeds/Planting Materials				
	Selection and development of stress tolerant and resilient seeds/planting materials	Stress tolerant and resilient varieties	National/Regional/SUCs/BPI/RFOs	2016-2022
		Seed buffering of stress tolerant and resilient crops		
		Varietal improvement		
	Improvement in the production and distribution of clean seeds	Adequate and sustainable supply of clean planting materials	National/Regional/SUCs/PhilRice/BPI	2016-2022
		Established seed banks	National/Regional/SUCs/PhilRice/BPI/RFOs	2016-2022
		Established farmer networks of seed producers		

Problems	Researchable Areas	Expected Outputs	Possible Implementing Agencies	Timeline
Seeds/Planting Materials				
	Adaptability trials of improved varieties	Production guide of stress tolerant and resilient crops	National/Regional/SUCs/PhilRice/BPI/RFOs	2016-2022
Water Management				
Increase in temperature causes water stress	Identification and development of water harvesting technologies	Location-specific recommendations of water harvesting technologies	BSWM/SUCs/International Agencies/RFOs	2016-2022
	Development of farming practices that enhances soil and water conservation	Location-specific improved strategies for soil and water conservation management	National/Regional/BSWM/SUCs/RFOs	2016-2022
	Development of efficient irrigation systems	Developed and pilot tested water management protocols and guidelines	BSWM/NIA	2016-2022
	Identification of diversified/integrated farming system suitable for different agro-climatic conditions (drought, flood salt water intrusion)	Recommendations on appropriate integrated farming systems for specific agro-climatic conditions	National/Regional/SUCs/RFOs	2016-2022
	Development of technologies for water use efficiency	Developed and pilot tested innovative technologies on water use efficiency	National/Regional/SUCs/RFOs/BSWM/International Agencies	2016-2022
Soil and Nutrient Management				
Drastic changes in temperature and precipitation patterns causes deterioration of soil quality	Identification and development of nutrient management technologies and techniques considering climate change vulnerability assessment	Developed site specific nutrient management that is landscape specific	National/Regional/BSWM/SUCs/RFOs/International Agencies	2016-2022
		Developed manuals/modules/AVPs for Site Specific Nutrient Management (SSNM)	National/Regional/BSWM/SUCs/RFOs/International Agencies	2016-2022

Problems	Researchable Areas	Expected Outputs	Possible Implementing Agencies	Timeline
Drastic changes in temperature and precipitation patterns causes deterioration of soil quality	Identification and development of technologies that increase soil fertility and improve nutrient uptake efficiency	Developed and pilot tested innovative technologies on nutrient management	National/ Regional/BSWM/ SUCs/RFOs/ International Agencies	2016-2022
	Determination of the effect of different stresses to soil characteristics across landscapes	Information of the different biotic and abiotic stresses and their effects to soil characteristics	National/ Regional/BSWM/ SUCs/RFOs/ International Agencies	2016-2022
	Estimation of GHG emission under different temperature regimes	Information on GHG emission and recommendations to lessen the emission	National/ Regional/BSWM/ SUCs/RFOs/ International Agencies	2016-2022
	Utilization of agricultural waste for nutrient recycling	Technologies on agricultural waste management/organic fertilizers etc.	National/ Regional/BSWM/ SUCs/RFOs/ International Agencies	2016-2022
Pest and Disease Management				
Shift in the crop-pest interactions as the timing of development stages in both hosts and pests is altered thus a change in disease pattern as well	Assessment and validation of existing and indigenous farmers practices on pest and disease management	Record/Documentation of indigenous farmers practices	National/ Regional/ SUCs/RFOs/ International Agencies/BPI/ NCPC	2016-2018
	Identification of major important disease/pest outbreaks that may result from different abiotic stresses related to climate change	Advisories on pest and diseases occurrence and management strategies	National/ Regional/ SUCs/RFOs/ International Agencies/BPI/ NCPC	2016-2022

Problems	Researchable Areas	Expected Outputs	Possible Implementing Agencies	Timeline
Shift in the crop-pest interactions as the timing of development stages in both hosts and pests is altered thus a change in disease pattern as well	Development of localized early warning systems (pest occurrence, pest prevalence) for predictive use	Guidelines and protocols for setting up of functional localized EWS in vulnerable areas	National/Regional/DOST/SUCs/RFOs	2016-2022
		Forecast models and pest and diseases for different crops	National/Regional/DOST/SUCs/RFOs	2016-2022
	Assessment of the effect of the different biotic stresses to the etiology and virulence of pathogens	Recommendations/management practices for the control and prevention of pest and diseases	National/Regional/SUCs/RFOs/International Agencies/BPI/NCPC	2016-2022
	Determination of population dynamics of present and emerging pests and diseases	Information on present and emerging pests and diseases	National/Regional/SUCs/RFOs/International Agencies/BPI/NCPC	2016-2022
	Development of management strategies for emerging pests	Pest management systems/strategies adapted to changing climate	National/Regional/SUCs/RFOs/International Agencies/BPI/NCPC	2016-2022
Weed Management				
Many weeds thrive under warmer temperature, wetter climate and increased CO ₂ level	Identification of biological control for weeds (applicable to pest, disease and weeds)	Developed modules/IEC materials on biological control methods for weed control	National/Regional/SUCs/RFOs/NCPC	2016-2018
	Determination of occurrence of invasive and emergent weed species	Recommendations/management practices for the control and prevention of weeds	National/Regional/SUCs/RFOs/NCPC	2016-2022

Problems	Researchable Areas	Expected Outputs	Possible Implementing Agencies	Timeline
Postharvest				
Unsuitable infra and machineries design; High postharvest losses	Development of new designs, construction protocols, postharvest storage facilities, machines, tools, and equipment that can withstand extreme climate events	Structural designs that can withstand extreme weather conditions, e.g. cold chain	PhilMech/RFOs/ SUCs	2016-2022
		New designs and construction protocols for agri-fishery infrastructure; energy-efficient, green and climate change adapted	PhilMech/RFOs/ SUCs	2016-2022
	Development of energy efficient machines and processes/methods for processing that can preserve quality and reduce losses	Postharvest equipment and practices that can preserve the quality and reduce losses	PhilMech/RFOs/ SUCs	2016-2022
	Inventory of existing climate change adaptation practices that can preserve quality of produce	Technologies/practices that can extend shelf-life of crop commodities	PhilMech/RFOs/ SUCs	2016-2022
Processing and Packaging				
Reduced quality of produce	Pilot testing of value adding technologies for agricultural produce to enhance resilience of farming households	Value adding Technologies/ processes and packaging materials that will prolong shelf life	SUCs/RFOs	2016-2022
		Institutional arrangements for processing involving women and other special groups	SUCs/RFOs	2016-2018
Marketing				
Volatile market pricing after extreme climatic events and inadequate market-related information/ challenges	Assessment of the shift in the consumption pattern, consumer behavior or preference for the new crop or varieties introduced	Market studies	SUCs/RFOs	2016-2018
	Conduct of value chain and utilization analysis	Market studies	SUCs/RFOs	2016-2018

Problems	Researchable Areas	Expected Outputs	Possible Implementing Agencies	Timeline
	Economic valuation of the effect of the different biotic stresses to crop production	Valuation studies	SUCs/RFOs	2016-2018
	Economic analysis of the strategies/interventions to crop production	Valuation studies	SUCs/RFOs	2016-2018
Policy				
Insufficient comprehensive and inclusive information on various socio-economic and institutional factors	Value chain and utilization analysis of climate tolerant and resilient crops (focusing on losses and damages)	Market studies	National/Regional/SUCs/RFOs	2016-2022
	Development of risk transfer mechanisms (crop insurance) development of insurance system (attractive insurance product)	Institutionalized Insurance system	PCIC/SUCs/RFOs	2016-2022
	Evaluation of previous on crisis and post crisis interventions	Documentation of interventions/best practice/lessons learned	National/Regional/SUCs/RFOs	2016-2018
	Crafting of enabling policies and support mechanisms on development and promotion of technologies to other areas (out-scaling)	Policies supporting the out-scaling/adoption of technologies	National/Regional/SUCs/RFOs	2016-2022
	Development of Commodity development/strategic plan to ensure long term production (national regional, local)	Commodity development/strategic plan	National/Regional/SUCs/RFOs	2016-2022
	Assessment of available credit facilities for farmers	Credit facility (analysis and status and recommendations)	National/Regional/SUCs/RFOs/PCIC	2016-2022
		Policy recommendations for easier access to insurance	National/Regional/SUCs/RFOs/PCIC	2016-2022

Problems	Researchable Areas	Expected Outputs	Possible Implementing Agencies	Timeline
	Design and establishment of national database for climate change	Knowledge information platform to facilitate information exchange sharing for all climate change adaptation strategies	SUCs/RFOs/ITCAF	2016-2022
	Institutional arrangement for resource sharing among small farming communities	Institutional models/arrangements	National/Regional/SUCs/RFOs	2016-2018
	Economic analysis of technologies at different scale and mechanism to sustain the use of technologies	Cost effective technologies	National/Regional/SUCs/RFOs	2016-2022
		Cost benefit analysis of different climate change adaptation strategies	National/Regional/SUCs/RFOs	2016-2022



Previous studies have focused only on few commodities, but there are still a lot of information gaps in the effects and impacts of climate change in the different crop species. The country still needs to pursue other studies on other major agricultural crops.





Livestock and Poultry

CLIMATE CHANGE RDE AGENDA 2016-2022

Global consumption, production, and trade of livestock products have increased rapidly in the last two decades and are expected to continue in the coming years (Hall et al., 2004). In reference to the Livestock, Poultry and Feeds Industry Roadmap, this broad trend is described by the Food and Agriculture Organization (FAO) as livestock revolution, which refers to the rapid increase in the consumption of livestock products with corresponding response from the industry to increase production. The roadmap recognized that the major contributors on the increase in consumption and production are developing countries particularly in Asia such as China, India, Indonesia, Philippines, Vietnam, Thailand, and Malaysia.

The aforementioned increase can be attributed primarily to the combination of population growth and changes in the diet of people which are driven by the increasing urbanization and growth in people's income (ILRI, 2000). The massive increases in demand for animal food products offer great opportunities for livestock producers in the developing countries.

In the Philippines, the poultry and livestock sector is a major contributor to the economy. The livestock and poultry sub-sectors are key contributors to agriculture gross value added (GVA) and together they account for about 34 percent of the total GVA (Table 4). The highest contribution can be attributed to the livestock sub-sector consisting of hogs, chicken, cattle, goats, and dairy at an average of 18.02 percent of agriculture GVA for the five-year period. On the other hand, the poultry group including chicken meat and eggs, duck meat and eggs account for 15-16 percent.



Table 4. Livestock and poultry share in GVA in agriculture excluding forestry, 2010-2014.
(Value at constant 2000 prices)

Particulars	2010	2011	2012	2013	2014
Agriculture GVA (million pesos)	659,989	676,075	695,130	701,325	712,559
Value (million pesos)					
Livestock	120,268	122,679	124,041	126,216	127,495
Poultry	100,965	105,379	110,136	114,859	115,169
Percent Share					
Livestock	18.22	18.15	17.84	18.00	17.89
Poultry	15.30	15.59	15.84	16.38	16.16

Source: Philippine Statistics Authority, 2015

In spite of its share to agriculture GVA, poultry and livestock production in the country is still predominantly of backyard scale and is to be found mostly in the subsistence mixed crop-livestock farming systems (Table 5). The presence of large piggeries and poultry

companies practicing vertical integration through sub-contracted poultry raising activities have increased the share of commercial swine and poultry production relative to the total inventory.

Table 5. Livestock inventory, 2014.

Species	Total	Commercial		Backyard	
		Number (heads/birds)	Percent	Number (heads/birds)	Percent
Carabao	2,847,445	11,627	0.41	2,835,818	99.59
Cattle	2,512,184	170,347	6.78	2,341,837	93.22
Goat	3,695,627	60,594	1.64	3,635,033	98.36
Hog	11,801,656	4,144,831	35.12	7,656,825	64.88
Duck	9,885,775	2,805,995	28.38	7,079,781	71.62

Source: Philippine Statistics Authority, 2015

Llorito (1993) and Alviola IV et al. (n.d.), as cited in ILRI (2000), recognized that the subsistence mixed crop-livestock farming system can be one of the contributing factors why the sub-sector remains low in productivity. Resource allocation within the crop-livestock system is usually biased towards improvement of the cropping systems leaving livestock production at the ‘marginal and peripheral’ side of the over-all farming operations.

Nonetheless, the dominant global and domestic trends of increasing consumption of animal products offer large opportunities to animal raisers. IFAD (2009) stated that livestock is a key asset for poor people, fulfilling multiple economic, social and risk management functions. It provides income-generating opportunities for the rural poor, has important roles in providing food security and psychosocial benefits and therefore it offers an escape route from poverty (ILRI, 2000 and Grace et al., 2015). Increased production of poultry and livestock products, whether from smallholder systems or otherwise, will lead towards decreasing relative and perhaps absolute real prices for animal-source foods, which will benefit both rural and urban poor. The more income, the more meat consumed, and an increase in income has a proportionally larger effect in the poorest countries (ILRI, 2000).

However, while climate change is a global phenomenon, its negative impacts are more

severely felt by poor people in developing countries who rely heavily on the natural resource base for their livelihoods. Rural poor communities rely greatly for their survival on agriculture and livestock keeping that are amongst the most climate-sensitive economic sectors (IFAD, 2009).



Comiso et al. (2015) stated that, the entire life cycle of livestock production from production of feeds to disposal of waste of animal products is affected. The direct impacts of climate change on livestock, such as high temperature and changing rainfall patterns result to reduction in the quantity and quality of feeds, heat stress, reduced water supply during extreme wet and dry periods, emergence and circulation of more virulent diseases, increased spread of existing vector-borne diseases and macroparasites

which may all lead to reduced feed intake and poor growth performance (Thornton et al, 2008 and IFAD 2009). Hence, ensuring good animal welfare will be paramount to addressing these challenges (UNFCCC, 2012).

The impacts of climate change heighten the vulnerability of livestock systems and exacerbate existing stresses (UNFCCC, 2012). Moreso, IFAD (2009) likewise recognized that these climate change impacts reinforce existing factors that are affecting livestock production systems, such as rapid population and economic growth, rising demand for food, and conflict over scarce resources such as land tenure, water, biofuels, etc. For rural communities, losing livestock assets could trigger a collapse into chronic poverty and have a lasting effect on livelihoods.

Ironically, livestock activities emit considerable amounts of greenhouse gases. Direct emissions from livestock come from the respiratory process of all animals in the form of carbon dioxide. Ruminants, and to a minor extent also monogastrics, emit methane as part of their digestive process, which involves microbial fermentation of fibrous feeds. Animal

manure also emits gases such as methane, nitrous oxides, ammonia, and carbon dioxide, depending on the way they are produced and managed.

Overall, livestock activities contribute an estimated 18 percent to total anthropogenic greenhouse gas emissions (FAO, 2006). This estimated livestock contribution represents the global greenhouse gas emissions. There are studies looking into the emissions and global warming potential of the various poultry and livestock animals in the Philippines as presented by Comiso et al., 2014 however, this pales in comparison with the emissions from other countries.

For 2012, the Philippine's total greenhouse emission (159.23 MtCO₂ e) including that of the contribution of the agriculture sector comprises to about 0.37 percent of the global total emission (43,286.11 MtCO₂ e) (WRI, 2014) (Table 6). The poultry and livestock subsector as well as the whole country historically does not significantly contribute to the global greenhouse gases. Although a number of studies have been conducted pursuing alternative and green sources of energy, of which animal wastes are included (Comiso et al., 2014).



Table 6. The Philippine's total greenhouse gas emissions, 2005-2012.

Year	Total GHG Emissions Excluding Land-Use Change and Forestry (MtCO ₂ e)	Total GHG Emissions Including Land-Use Change and Forestry (MtCO ₂ e)
2005	143.27	140.21
2006	136.17	133.24
2007	141.94	139.22
2008	145.26	142.74
2009	147.67	145.38
2010	153.99	152.02
2011	155.47	153.62
2012	159.23	157.59

Source: Climate Analysis Indicators Tool (CAIT) 2.0, 2014 World Resources Institute

Climate, in the foreseeable future, poses a lot of risks and uncertainties for the poultry and livestock sector. There are a number of studies conducted but there is still a need to do more research and development work for better understanding and for developing climate-resilient and sustainable management practices and systems.

The Livestock, Poultry and Feeds Industry Roadmap identified that the program focus of DA can be broadly categorized as follows:

1. Genetic improvement
2. Disease control and eradication
3. Research, extension and training
4. Postharvest and infrastructure development

5. Market development and export initiatives

6. Dairy development and expansion

7. Meat quality and safety

The program aimed to modernize and restructure the production and post-production system to provide nutritious, safe, accessible, and convenient products that satisfy changing consumers' needs in a manner that is mutually profitable and equitable along the value chain in the era of globalization. The department moreover aims to also build the adaptive capacities of men and women in the communities and to promote low-carbon measures/activities/technologies, which hopefully lead to the sustainable, progressive, and resilient sector amidst the changing climate.



Problems	Researchable Areas	Expected Outputs	Possible Implementing Agencies	Timeline
Input				
Moisture stress and limited soil nutrient availability resulting to low availability and increasing price of feeds, forages and other plant-relying inputs	Selection/breeding of stress-tolerant forages and feedstock varieties	Identified stress-tolerant cultivars	National/ Regional/SUC in collaboration with International Agencies	2016-2022
	Identification and utilization of affordable and locally available indigenous feeds and feedstock	Updated manual of identified alternative indigenous feeds and feedstock	National/ Regional/SUC in collaboration with International Agencies	2016-2022
	Evaluation of utilization of alternative indigenous feeds and feedstock	Information and recommendation on new feeds and feeding strategies	National / Regional / SUCs / LGUs	2016-2020
	Development of new farming systems adapted to climate change conditions	Models or framework of recommended new farming systems (e.g. Feedcrop-Livestock-Poultry Food-Feed Systems)	National/ Regional/SUC in collaboration with International Agencies	2016-2022
Low volume and quality of feeds and forages; high incidence of spoilage of stored feedstuff or feed ingredients	Development and evaluation of appropriate feed processing and storage systems	Improved feed processing procedures/ methodologies and storage system designs	National/ Regional/SUCs/ PhilMech	2016-2022
	Studies on the value and utilization of supplements for improved animal digestive health	Identified and recommended dietary animal supplementation (e.g. pre and probiotics)	SUCs	2016-2022
	Development of machines and other small farm equipment e.g. baling and pelleting machine	Locally-adapted machines and small farm equipment	PHILMECH/ SUCs	2016-2022
	Development of quick test kits for feed contamination determination	Quick test kits for feeds with simplified product usage guide/instructions	PCC / UPLB Biotech	2016-2018

Problems	Researchable Areas	Expected Outputs	Possible Implementing Agencies	Timeline
Unsuitable housing and infrastructure designs	Development and evaluation of climate-resilient housing/ infrastructure designs and construction protocols	Structural designs and protocols that can adapt/ withstand varying and extreme weather conditions	SUCS with Engineering Expertise	2016-2020
Production				
Poor reproduction efficiency of breeder stocks and animals	Assessment of risk, exposure, sensitivity and over-all vulnerability of economically important breeds and native animals	Synthesis of evidences/ information on the risk, exposure, sensitivity and over-all vulnerability of animals	BAI / PCC / SUCs / DOST / RFOs	2016-2018
	Comparative analysis of the different and existing breeds in the country in response to change in climate, temperature, and humidity	Identified and recommended climate-resilient and resource-efficient as well as alternative and suitable breeds and lines	BAI / PCC / SUCs / DOST / RFOs/ LGUs	2016-2022
	Development of animal breeds and lines suitable/ adaptable to changing climatic conditions		BAI / PCC / SUCs / DOST / RFOs/ LGUs	2016-2022
	Performance evaluation of different breeds under different production systems		BAI / PCC / SUCs / DOST / RFOs/ LGUs	2016-2022
	Conservation and improvement of livestock and poultry recommended breeds		BAI / PCC / SUCs / DOST / RFOs	2016-2022
General reduction of the animals' production performance/ efficiency	In-depth analysis of animal-environment interaction within the climate change context	Baseline information on the effect of environmental changes to animal physiology and behavior	BAI/PCC / SUCS with Veterinary Expertise / RFOs	2016-2017
	Development and evaluation of feeds and feeding systems which are responsive and adapted to climatic changes	Manual/module on climate-smart feeding technologies/ strategies/systems (e.g. dietary and rumen manipulations)	SUCs / BAI / PCC / RFOs	2016-2017
	Development and evaluation of sustainable and climate-resilient production and management practices	Designs/models/frameworks for sustainable and climate-resilient production and management practices	SUCs / BAI / PCC / RFOs	2016-2017

Problems	Researchable Areas	Expected Outputs	Possible Implementing Agencies	Timeline
	Performance evaluation of different breeds under different production systems		BAI / PCC / SUCs / DOST / RFOs/ LGUs	2016-2022
	Conservation and improvement of livestock and poultry recommended breeds		BAI / PCC / SUCs / DOST / RFOs	2016-2022
General reduction of the animals' production performance/ efficiency	In-depth analysis of animal-environment interaction within the climate change context	Baseline information on the effect of environmental changes to animal physiology and behavior	BAI/PCC / SUCS with Veterinary Expertise / RFOs	2016-2017
	Development and evaluation of feeds and feeding systems which are responsive and adapted to climatic changes	Manual/module on climate-smart feeding technologies/ strategies/systems (e.g. dietary and rumen manipulations)	SUCs / BAI / PCC / RFOs	2016-2017
	Development and evaluation of sustainable and climate-resilient production and management practices	Designs/models/frameworks for sustainable and climate-resilient production and management practices	SUCs / BAI / PCC / RFOs	2016-2017
Increase in pest and disease infestation and severity and emergence of new, infectious and parasitic diseases	Epidemiological studies of major and emerging pests and diseases of economically important breeds and native animals	Pest/disease forecasting models/maps and recommended eradication and control management strategies or schemes	BAI/PCC / SUCS with Vet Expertise	2016-2017
	Development of cost-effective disease detection and monitoring tools for both commercial and native breeds	Diagnostic test kits with simplified product usage guide/instructions	BAI/PCC / SUCS with Vet Expertise	2016-2017
	Development and evaluation of alternative and affordable animal health care	Indigenous ethno-veterinary drugs/products	BAI/PCC / SUCS with Vet Expertise	2016-2017
High postharvest losses and poor quality of animal products	Assessment of postharvest losses and evaluation of the different practices that affect perishability of animal products of smallhold producers and processors	Baseline information and profile of the extent of postharvest losses and practices	National / Regional / SUCs / LGUs	2016-2020
		Designs/models of appropriate cold chain facilities and transport infrastructure	National / Regional / SUCs / LGUs	2016-2020

Problems	Researchable Areas	Expected Outputs	Possible Implementing Agencies	Timeline
Postharvest and Processing				
		Proper sanitary and phyto-sanitary processing, handling and storage procedures/ protocols for smallhold producers and processors	National / Regional / SUCs / LGUs	2016-2020
	Identification/evaluation of appropriate equipment and packaging materials that reduce postharvest contamination and prolong shelf life of animal products	Developed appropriate equipment and packaging materials	National / Regional / SUCs / LGUs	2018-2022
	Development and evaluation of Rapid Test Kit for the determination of microbial and chemical safety of meat and milk products	Rapid test kits with simplified product usage guide/ instructions	National / Regional / SUCs / LGUs	2016-2018
Marketing				
Inadequacy of current and updated market-related information for poultry and livestock products	In-depth analysis and assessment of poultry and livestock value chain	Value-chain models for poultry/livestock products and improved marketing strategies for smallholder farmers	National / Regional / SUCs / LGUs	2016-2022
	Acceptability studies of animal products from developed climate resilient breeds	Information on the degree of acceptance and consumer preference of animal products from developed climate resilient breeds	National / Regional / SUCs / LGUs	2020-2022
	Supply and demand analysis of poultry and livestock products	Updated market-related baseline information on prices, channels and supply-demand gaps	National / Regional / SUCs / LGUs	2020-2022

Problems	Researchable Areas	Expected Outputs	Possible Implementing Agencies	Timeline
Policy				
Insufficiency of comprehensive and inclusive information on various socio-economic, institutional and political factors playing crucial roles in the poultry and livestock sector	Risk assessment and economic valuation studies of the effects of climate change in priority vulnerable areas	Baseline information on risk factors, degree of impact, extent of damage, social/ disaster preparedness and recommended specific tools, strategies for the detection, estimation, analysis and over-all management of risks	SUCs/PCC/BAI	2016
	Review of policies and programs related to climate change in poultry and livestock sector	Policies and/or enabling mechanisms supportive to improved climate change adaptation measures (e.g. insurance, credit and other safety nets)	National / Regional / SUCs / LGUs / PCC	2016-2017
	Socio-economic studies on poultry and livestock stakeholders in priority vulnerable areas	Demographic profile of stakeholders for prioritization of government programs for smallhold producers and processors	National / Regional / SUCs / LGUs / PCC	2016-2018
		Policy recommendations on the identified support services for the poultry and livestock sector in priority vulnerable areas	National / Regional / SUCs / LGUs	2018-2019
	Studies on effective communication approaches and modalities for the adoption of climate change-related technologies	Developed manual/guide/ other IEC materials for LGU and other extension service providers	National / Regional / SUC / LGU / ATI	2016-2018
Greenhouse gas emissions from poultry and livestock animals/ farms	Development and evaluation of waste management technologies	Designs/models/strategies on capturing and converting emitted gas into alternative energy (i.e. biofuel or biogas production)	National / Regional / SUC / LGU	2016-2018
		Developed products from animal wastes	National / Regional / SUC / LGU / PCC	2016-2018

Climate, in the foreseeable future, poses a lot of risks and uncertainties for the poultry and livestock sector. There are a number of studies conducted but there is still a need to do more research and development work for better understanding and for developing climate-resilient and sustainable management practices and systems.







Fisheries and Aquaculture

CLIMATE CHANGE RDE AGENDA 2016-2022

In the global scenario, fisheries and aquaculture plays an important role in ensuring food security and reducing poverty of the population. The global fish production, both aquaculture and capture fisheries, has constantly grown in the last five decades with an increasing supply of food fish at an average of 3.2 percent per year. Parallel with the increasing supply, the world per capita fish consumption is also estimated to be 19.2 kg in 2012, a significant increase compared to 9.9 kg in the 1960's (FAO, 2014). This significant global development in fisheries and aquaculture is attributed to population growth, rising incomes and urbanization coupled with expansion of fish production, and improved distribution channels (FAO, 2014).



The Philippines has high dependency on aquatic ecosystem for both fisheries and aquaculture sector in providing trade, employment opportunities, and food security. The sector has contributed a total volume of production of 4,705,400 metric tons in 2013 with a total value of production amounting to PhP 244,551,675,070.00. Of the total volume of production in 2013, 62 percent came from capture fisheries and 38 percent from aquaculture (Table 7).

Table 7. Fisheries volume and value of production, 2011-2013.

Item	2011		2012		2013	
	Volume ('000 mt)	Value (in million pesos)	Volume ('000 mt)	Value (in million pesos)	Volume ('000 mt)	Value (in million pesos)
All Sectors	4,973.5	224,695.0	4,865.1	237,711.4	4,705.4	244,551.6
Commercial	1,032.8	58,623.0	1,042.3	65,894.2	1,067.6	69,922.5
Municipal	1,332.6	80,075.6	1,280.8	79,527.3	1,264.4	80,898.0
Marine	1,138.9	72,028.1	1,083.4	70,982.7	1,062.1	71,909.3
Inland	193.7	8,047.5	197.4	8,544.6	202.3	8,988.7
Aquaculture	2,608.1	85,996.4	2,542.0	92,289.9	2,373.4	93,731.2
Brackish water Fishpond ¹	311.1	43,520.3	320.2	46,491.2	327.4	48,552.4
Freshwater Fish cage/ pen	164.0	10,234.6	165.4	11,713.3	170.5	11,407.2
Freshwater Fish-pond ²	142.9	9,126.2	144.7	9,967.8	148.3	10,876.6
Marine Fish cage/ pen	105.4	11,310.5	114.3	13,917.3	123.8	12,568.0
Others	1,884.7	11,804.2	1,797.4	10,200.0	1,603.4	10,326.7

Source: Philippine Statistics Authority, 2014

¹ Includes brackish water pen/cage

² Includes small farm reservoir and rice fish

Employment in fisheries and aquaculture is estimated to be 1.5 million people in 2010. In 2012, the Bureau of Fisheries and Aquatic Resources (BFAR) reported that the fishing industry employed a total of 1,614,368 fishing operators wherein about 1,371,676 were engaged in municipal fisheries while around 16,497 are involved in commercial fishing operations. Aquaculture, on the other hand, employed around 226,195 operators.

Given the dependence and contributions of fisheries and aquaculture in providing food for the Filipinos, there is an increasing recognition of the vulnerability of the sector to climate

of coastal communities (Capili, Ibay, and Villarin, 2005).

It cannot be undermined that fisheries productivity is dependent on the health and functioning of the ecosystem. With climate change as an added factor, fisheries and aquaculture production systems are highly influenced but the impact is dependent on a particular climate change “driver” or synergy of “drivers”. These climate change “drivers” are classified as sea surface temperature, rising sea level, changes in rainfall and water availability, higher inland temperatures, increase frequency and/or intensity of storms and drought, changes



change. In fact, recent scenarios showed that coastal areas are at the forefront when it comes to the direct impacts of climate change. Coastal communities that are highly-dependent on fisheries with low adaptive capacity are most vulnerable to socio-economic implications. Also, projected changes in climate will significantly affect the yield of coastal fisheries and welfare

in El Niño-Southern Oscillation (ENSO) and ocean acidification. Exposure of fisheries and aquaculture to these drivers is projected to have an effect on the biophysical and ecological state of the aquatic environment, change the species compositions and distribution of fishes and substantially impact catch potential and aquaculture production (FAO, 2011).

The complex nature of fisheries and aquaculture requires immediate and long-term studies on the dynamics of the aquatic system in the context of a changing climate.

To date, there are limited climate-related studies that focused on fisheries and aquaculture. Studies were mostly on vulnerability assessments of coastal areas and the development of vulnerability assessment tools. The University of the Philippines Diliman-Marine Science Institute (UP-MSI) developed a guidebook of vulnerability assessment tools for coastal system to improve coastal resources management (MERF, 2013). There were also studies by Jacinto et al. (2015) wherein a sector-based fisheries vulnerability assessment tool (Fish Vool) to evaluate the vulnerability of tuna and sardines in General Santos and Zamboanga City was developed. Reyes and Blanco (2012) and Perez (unpublished) also conducted vulnerability assessment studies in Bolinao and Manila Bay, respectively. A projection map of ocean climate in the Philippines based on combined climate change exposures of sea surface temperature, rainfall and sea level rise was generated by David et al. (n.d.).

The WorldFish Center conducted studies on economic analysis of adaptation strategies to climate change in selected coastal areas in the Philippines. The project realized policy implications encompassing issues of poverty and environmental degradation, rationalization of economic and non-economic interventions, increasing effectiveness of autonomous adaptation, enhancing relationships within communities and effective public/planned adaptation interventions (Perez, et al., 2013).

In response to the projected and evident climate change scenarios in the country, research and

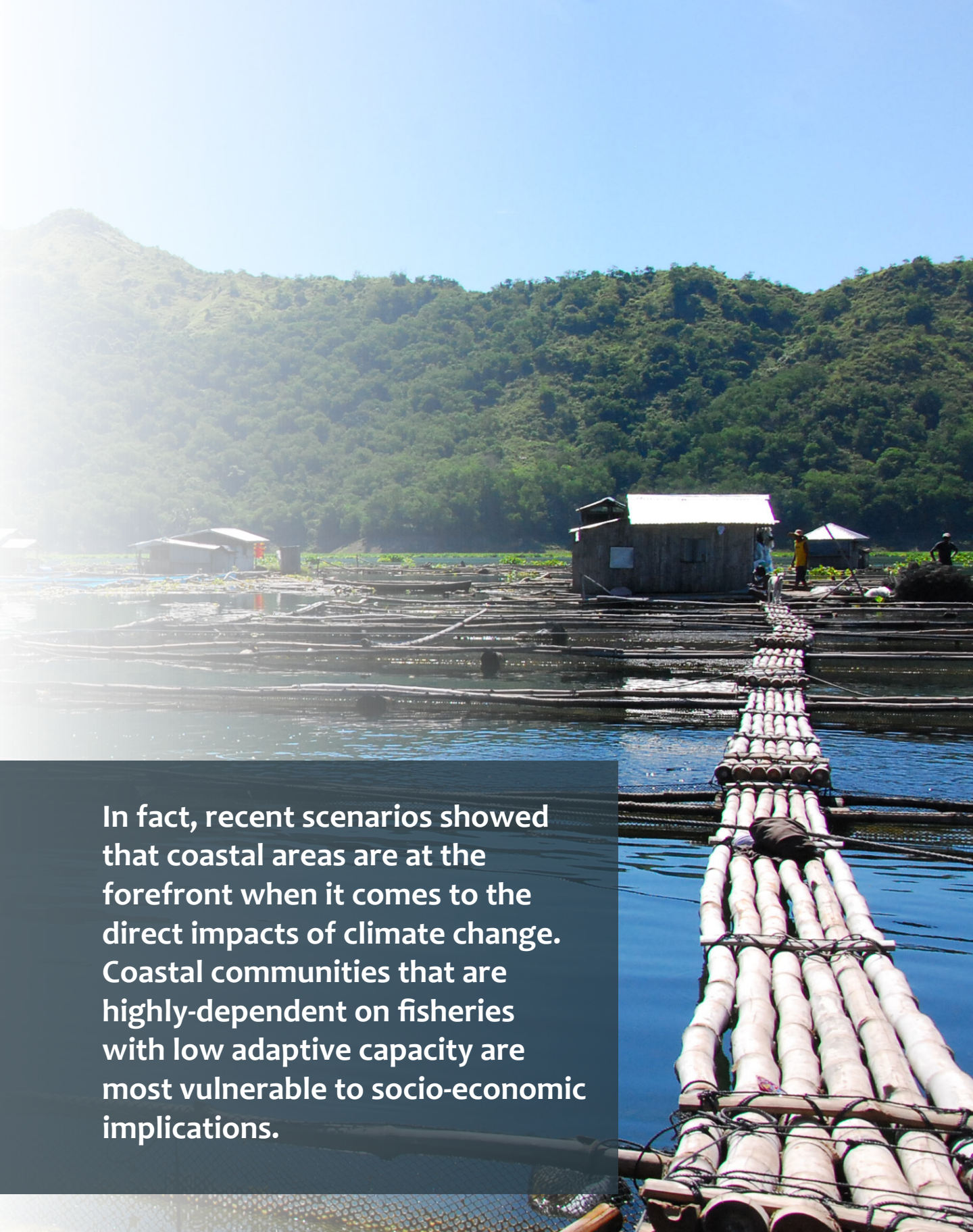
development is one of the empirical approaches towards understanding and enhancing adaptive capacities to climate change impacts of fisheries and aquaculture sector. In consonance with the DA's initiative of mainstreaming climate change in its plans and programs, the following are broad strokes of the identified researchable areas towards the attainment of a climate-resilient fisheries and aquaculture sector:

Aquaculture

1. Development/improvement of inputs and infrastructures for aquaculture of high value species and other species with potential for food and aquaculture;
2. Improvement of aquaculture production;
3. Development and improvement of post-harvest technologies;
4. Development of climate responsive market for aquaculture products; and
5. Policy recommendations to enhance climate change adaptation and mitigation policies and programs for fisheries and aquaculture.

Capture Fisheries

1. Spatial distribution and migration patterns of fish and socio-economic implications of changes in resources availability;
2. Development of early warning systems inclusive of marine biodiversity and habitat;
3. Improvement of post-harvest technologies and food safety of major food fish species;
4. Recommendations for enhancing resiliency of fisheries infrastructures; and
5. Vulnerability assessment studies of coastal areas.



In fact, recent scenarios showed that coastal areas are at the forefront when it comes to the direct impacts of climate change. Coastal communities that are highly-dependent on fisheries with low adaptive capacity are most vulnerable to socio-economic implications.

Problems	Researchable Areas	Expected Outputs	Possible Implementing Agencies	Timeline
AQUACULTURE				
Input				
Seeds				
Change in spawning habitats, spawning time, seed availability for aquaculture and potential negative impacts on hatchery and nursery rearing operations	Development/ improvement of hatchery techniques for cultured high value species dependent on the wild for fry/fingerlings; understanding changes in spawning and larval patterns for key aquaculture species; Identification and management improvement of spawning areas	Manual on improved hatchery techniques	BFAR-NFRDI HEIs	2016-2018
	Inventory of new fish species with potential for food and aquaculture	List of stress tolerant fish species with aquaculture potential;	BFAR-NFRDI HEIs	2015-2016
		Maps of sources of seeds;		2016-2017
		Closing of the production protocol for alternative fish species		2016-2022
		Identification of resilient areas for spawning		
Feeds				
Shortage or inaccessible of fish meal for aquaculture	Identification and/or development of alternative fish feeds	List of alternative sources and production protocols	BFAR-NFRDI HEIs	2016-2018
	Evaluation, formulation and improvement of viable and locally available sources for existing additives, i.e. probiotics and prebiotics	List of viable, local sources for additives Recommended additives for fish feeds	UP-Biotech HEIs BFAR-NFRDI	2016-2019

Problems	Researchable Areas	Expected Outputs	Possible Implementing Agencies	Timeline
Space				
Increased competition/ conflict with other land and water users	<p>Development of climate responsive land and water management strategies;</p> <p>Assessment of water budget of key watersheds</p>	<p>Climate responsive land and water management models for sustainable aquaculture;</p> <p>List of water budget for key watersheds in support to aquaculture</p> <p>Recommended land and water use for key production areas</p>	HEIs ICRAF BSWM	2016-2017
Infrastructure				
Infrastructure damage or loss of aquaculture facilities	<p>Assessment of infrastructure integrity vis-à-vis climate change;</p> <p>Impact of climate change on aquaculture infrastructure;</p> <p>Improving agriculture and fisheries infrastructure design standards and construction protocols for climate change adaptation</p>	<p>Baseline information on infrastructure integrity for aquaculture production;</p> <p>Estimation of loss in aquaculture production due to climate change i.e. salt water intrusion, flooding, erosion;</p> <p>Climate-proof infrastructure design/models and standards</p>	<p>HEIs BFAR-NFRDI WorldFish</p> <p>PhilMech BFAR-NFRDI HEIs</p>	<p>2018-2020</p> <p>2020-2022</p>
Production				
Changes in species growth due to fluctuations in water parameters; Increased cost of aquaculture production	Performance evaluation of key aquaculture species amidst climate change; Development and improvement of alternative aquaculture species and strains that are resistant to biotic and abiotic stresses brought by the changing climate	List of stress tolerant fish species/strains, breeding and culture protocols	BFAR-NFRDI HEIs	2016 onwards (continuing efforts)

Problems	Researchable Areas	Expected Outputs	Possible Implementing Agencies	Timeline
	Development and improvement of climate resilient culture management practices for key aquaculture species	Manual of new and improved climate resilient culture management practices	BFAR-NFRDI HEIs LGUs	2016-2017
	Identification and assessment of secondary stressors (i.e. invasive species, HABs, microbes, etc) due to climate change for key aquaculture species	Information on secondary stressors and its effect on aquaculture production; Management protocols for secondary stressors	BFAR-NFRDI HEIs LGUs Coast Guard R&D arm	2017-2019
Fluctuating water quality and reduced oxygen carrying capacity affecting stocking densities and production in general	Assessment of existing and potential mariculture sites amidst climate change	Climate resilient Mariculture Zoning System	BFAR-NFRDI UP LGUs MSU-Naawan	2017-2020
	Studies on water quality changes brought about by the changing climate and climate variations	Information on water quality changes due to climate change and its effect on aquaculture production; Response protocols to changes in water quality indicators Roll out of existing response protocols to water quality changes	BFAR-NFRDI HEIs	2017 onwards
	Development of early warning systems to minimize losses from fish kill	Early warning systems framework/model, protocols and roll out	BFAR-NFRDI UP-MSI HEIs	2016 onwards
	Analysis of carrying capacity of aquaculture areas amidst climate change	Piloting of existing models for enhancing carrying capacity of selected aquaculture sites; Enhancement of existing models for climate change resilience	UP-MSI WorldFish BFAR-NFRDI	2016-2020

Problems	Researchable Areas	Expected Outputs	Possible Implementing Agencies	Timeline
Changing and increased susceptibility of some stocks to pest and diseases due to climate change	Identification, management and control strategies for emerging and existing pests, diseases, including fouling organisms, due to changing climate conditions	Baseline information on pests, and diseases and their respective management protocols	BFAR-NFRDI HEIs	2016-2017
Reduction or loss (in some areas) of freshwater due to saline water intrusion	Studies on potential expansion areas for aquaculture, ie. those affected by salt water intrusion	Map of potential expansion areas or aquaculture	BFAR NFRDI	2015-2017
	Evaluation of new species for brackishwater aquaculture production	Pilot testing of identified species for culture in brackishwater condition	BFAR-NFRDI HEIs SEAFDEC	2017-2022
Postharvest and Processing				
Increased postharvest losses due to climate change	Improvement of current harvesting techniques and equipments to minimize losses	Protocol and technology on improved fish harvesting techniques; Prototype of the improved post harvest equipment	BFAR-NFRDI HEIs PhilMech	2016-2017/ 2016-2018
	Assessment of nutrient content of major aquaculture species	Baseline information on nutrient content of major aquaculture species for food security	BFAR-NFRDI HEIs DOST-FNRI UP	2017-2018
	Identification and development of value adding techniques for key aquaculture species	High value products from key aquaculture species; Value adding techniques for processing aquaculture products	HEIs DOST Regional Offices BFAR-NFRDI	2015-2016

Problems	Researchable Areas	Expected Outputs	Possible Implementing Agencies	Timeline
Marketing				
Lack of market-related information for aquaculture products	Development of pathways for sustainable climate responsive aquaculture production systems	Policy recommendations on investment areas for climate responsive aquaculture production systems	HEIs WorldFish BFAR-NFRDI NEDA-PIDS	2016-2018
	Development of the value chain for aquaculture products amidst climate change	Recommendations and IEC on sustainable value chains for climate resilient aquaculture products; Strategic investment plans within the value chain	HEIs WorldFish BFAR-NFRDI LGU	2017-2018
Policy				
Fisheries and aquaculture is not a priority on the decision making of the government	Assessment and evaluation of climate change mitigation and adaptation policies and programs and how fisheries and aquaculture issues are being addressed	Recommendations to enhanced climate change adaptation and mitigation policies and programs that incorporate fisheries and aquaculture needs amidst climate change	WorldFish SEARCA UP	2016-2018
	Policy research promoting strengthened private-public partnership for aquaculture	Recommendations on how to strengthen PPP as input for the implementing guidelines	LGU, BFAR-NFRDI HEIs	2018
	Assessment of information and communication strategies for effective and sustainable transfer of climate change-related technologies	Identified IEC and capacity building needs	HEIs DOST-RACO ATI	2016-2017
	Evaluation of insurance policies for aquaculture	Recommendations to insurance companies/ PCIC to provide protection and security for mariculture investors	HEIs BFAR-NFRDI	2016-2017

Problems	Researchable Areas	Expected Outputs	Possible Implementing Agencies	Timeline
Management of threatened and endangered species	Identification and tagging of cultured regulated species; Policy analysis of regulated species amidst climate change	Recommended technology and policy measures for management of threatened and endangered species	BFAR-NFRDI HEIs LGUs DENR-BMB	2018-2020
CAPTURE FISHERIES				
Production				
Loss of habitats, lower reproductive rates, greater mortality and low population growth rates for fish	Study on changes in spatial distribution and migration patterns of fish over time; Vulnerability of habitat-associated fisheries industry (i.e. ornamentals, live fish, siganids); Rehabilitation strategies of key habitats	1. Recommendations for zoning and appropriate management strategies; 2. Established estimate on the change in fish stock; 3. Establishment of the patterns of demographic connectivity of fisheries relevant species 4. Integration of the population level data from selected species into ecosystem-based fisheries management approaches; and 5. Habitat rehabilitation strategies	BFAR-NFRDI LGUs HEIs DENR-BMB WorldFish	2017-2020
Potential loss of species and altered species composition and the eventual changes in fishing grounds	Analysis of the local and regional potential changes in resource importance and composition and likely socio-economic impacts	1. Prioritized resource needs and appropriate lead institution/organization; 2. Map of fish stocks locations and resource assessments; 3. Identified socio-economic impacts; 4. Baseline information on the reproductive biology of major marine species;	BFAR, NFRDI, SUCs, Research Institutions, LGUs, NGOs, DENR	2017-2020
	Monitoring and early warning system (including biodiversity and habitat monitoring)	Established strategies and management systems i.e. HABs, capture fisheries	BFAR-NFRDI HEIs UP LGUs DENR-BMB WorldFish	2016-2018

Problems	Researchable Areas	Expected Outputs	Possible Implementing Agencies	Timeline
Postharvest and Processing				
Increased postharvest losses and/or low quality products from capture fisheries	Documentation of indigenous village-level fishing techniques and assessment of potential for climate resilience	Case study of climate resilient indigenous fishing practices	BFAR-NFRDI HEIs LGUs NGOs	2016-2018
	Assessment of food safety of major food fish species	Information on food safety issues from capture fisheries; Food safety standards for food fish; Rapid assessment kits for food safety	BFAR-NFRDI HEIs DOST-FNRI UP NFA-FDC DENR-EMB	2016-2018 (food safety)/ 2018 -2020 (standards)/ 2020 - onward (assessment kits)
	Identification and development of value adding techniques from capture fisheries	High value products from capture fisheries; Value adding techniques for processing capture fisheries products	HEIs DOST Regional Offices BFAR-NFRDI	2015-2016
Policy				
Vulnerability of capture fisheries infrastructures	Appropriateness of sites and technologies for Constructing climate resilient capture fisheries related infrastructures	Climate resilient capture fisheries infrastructures (e.g. fish ports, ice plants, fish landings sites, among others)	BFAR-NFRDI HEIs PPA LGUs	2018-2020
	Improving fisheries infrastructure design standards and construction protocols for climate change adaptation	Identified appropriate alternative materials for fishing paraphernalia; Standardized, climate-proof facility	BFAR-NFRDI HEIs PPA LGUs	2020-2024
Vulnerability of coastal communities to climate change	Vulnerability and Risk Mapping of Coastal Areas, Marine Resources, Marine Protected Areas and fishing villages	Available GIS maps for management of vulnerable Coastal Areas, Marine Resources, Marine Protected Areas and fishing villages	UP BFAR-NFRDI HEIs SEARCA LGUs	2016-2017

Problems	Researchable Areas	Expected Outputs	Possible Implementing Agencies	Timeline
	Evaluation/assessment of abandoned/unused/underutilized fishponds for conversion to mangrove areas	1. Environmental and species suitability maps established; 2. Map and database of unused and underutilized fishponds	BFAR,NFRDI HEIs LGUs DENR-ERDB	2017-2018
	Socio-economic studies on climate change behavior, adaptation systems, risk transfer and social protection mechanisms for fisheries	Identified and recommended strategies and guidelines on CC vulnerability and risk transfer and social protection mechanisms for fish habitats and fishery communities	BFAR-NFRDI HEIs LGUs WorldFish	2017-2018
Under valuation of the potential freshwater and seasonal flood plains fisheries production	Assessment of potential freshwater and seasonal flood plains fisheries production	Policy recommendations on freshwater and seasonal flood plains fisheries production	BFAR- NFRDI HEIs LGUs WorldFish	2017-2018

CLIMATE CHANGE

MAINSTREAMING CHECKLIST FOR R&D PROPOSALS

CLIMATE CHANGE PROJECT PROPOSAL

Mainstreaming Checklist

(To be filled-out by the proponents and must be attached to the prescribed format of capsule/detailed proposal)

Part I. Basic Information

Project Title:	
Implementing Agency:	
Collaborating Agency (ies):	
Project Duration:	
Proposed Budget:	
Project Leader:	

Part II. Mainstreaming Checklist (Please check the appropriate rating/boxes)

QUESTION	RATING			
	None	Low	Medium	High
1. What is the level of risk of the proposed project's commodity-of-interest (i.e. crops, poultry and livestock, and fisheries and aquaculture) in terms of the following events:				
Changing rainfall patterns				
Drastic temperature changes				
Drought				
Erosion				
Sea level rise (SLR)				
Salt water intrusion (SWI)				
Ocean acidification				
Typhoon				
Flood				
Landslide				
Storm surge				
2. What is the level of risk of the proposed project's area (or project site/s) in terms of the following events:				
Changing rainfall patterns				
Drastic temperature changes				
Drought				
Erosion				
Sea level rise (SLR)				
Salt water intrusion (SWI)				
Ocean acidification				
Typhoon				
Flood				
Landslide				
Storm surge				
3. What is the level of risk of the project's target beneficiaries (i.e. farmers/fishers/processors/ market players/consumers) from these events:				
Changing rainfall patterns				
Drastic temperature changes				
Drought				
Erosion				
Sea level rise (SLR)				
Salt water intrusion (SWI)				
Ocean acidification				
Typhoon				
Flood				
Landslide				
Storm surge				

Part III. Mainstreaming Checklist (Please explain as concisely possible)

1. Does this proposed project align with and fit in either of the DA-BAR Climate Change R&D Agenda and Programs (CC RDEAP) or the DA-BAR National RDE Agenda and Programs (NRDEAP)?

What agenda? _____

2. Will the proposed project contribute to the increased understanding (i.e. current or future) of the climate-change related identified hazards/events (i.e. changing rainfall patterns, drastic temperature change, drought, erosion, SLR, SWI, ocean acidification, typhoon, flood, landslide and storm surge)?

If Yes, how? _____

If No, why? _____

3. Will the proposed project contribute to the increased adaptive capacity of the farmers and fishers?

If Yes, how? _____

If No, why? _____

4. Will the proposed project contribute to the reduction of greenhouse gases?

If Yes, how? _____

If No, why? _____

5. Will the proposed project contribute to the protection and integrity of the environment?

If Yes, how? _____

If No, why? _____

6. Will the proposed project contribute to the increase in yield, production, and productivity of the commodity-of-interest?

If Yes, how? _____

If No, why? _____

7. Will the proposed project contribute to the increased income and sustainable livelihoods of farmers and fishers?

If Yes, how? _____

If No, why? _____

8. Is there a high level of participation from the farmers and fishers involved in the proposed project?

If Yes, how? _____

If No, why? _____

9. Beyond the identified target beneficiaries, are there others who are likely to gain from the proposed project?

If Yes, who else? _____

If No, why? _____

10. Does the proposed project involve or necessitate support from other organizations, offices and agencies?

If Yes, what organizations/offices/agencies? _____

If No, why? _____

REFERENCES:

- Adams, P.W. and A. B. Hairston. (1995). Using scientific input in policy and decision making. Oregon State University Extension Service. Retrieved from: <http://www.oregon.gov/LCD/OPAC/docs/resources/UsingScientificInput.pdf>
- Adams, R., Hurd, B., Leary, N., and Lenhart, S. (1998). Effects of global climate change on agriculture: an interpretative review. *Climate Research* , 11, 19-30.
- Administrative Order (A.O.) 2010-01. Implementing Rules and Regulation of the Climate Change Act of 2009. Retrieved from: <http://www.climate.gov.ph/images/docs/AO2010-10.RA%209729IRR.pdf>.
- Aliño, P.M., Follosco, N.M.G., Mamauag, S.S., Martinez, R.J.S. and Panga, F.M. 2013. Chapter 7: Linking Vulnerability Assessment to Adaptation. In: Marine Environment and Resources Foundation, (MERF) Inc., 2013. *Vulnerability Assessment Tools for Coastal Ecosystems: A Guidebook*. Quezon City, Philippines: MERF, Inc..
- Ancog, R., Sajise, A. J., and Sombilla, M. (2012). *Socioeconomics of Climate Change in the Philippines: A Literature Synthesis (1990-2010)*. Los Banos, Laguna: SEARCA and PCAARRD.
- Bureau of Fisheries and Aquatic Resources (BFAR). (2012). *Philippine Fisheries Profile 2012*. Quezon City: Department of Agriculture-BFAR.
- Capili, E. B., Ibay, A. C., and Villarin, J. R. (2005). *Climate Change Impacts and Adaptation on Philippine Coasts*. Proceedings of the International Oceans 2005 Conference, (pp. 1-8). Washington D.C., USA.
- Climate Change Commission. (2010). *National Climate Change Action Plan 2011-2028*. Manila: Climate Change Commission.
- Climate Change Commission. (2013). *Philippines Research & Development Agenda in Support of the National Climate Change Action Plan Strategic Priorities (2011 - 2028)*.
- Comiso, J.C., Blanche, C. A., Sarigumba, T. I., Espaldon, M.V. O., Lansigan, F. P. Baguinon, N.T. Birosel, R.C., Colladilla, J.O., Cruz, R.V.O., Florece, L.M., Guerrero, R. D. III, Lasco, R. D., Perez, R.T. Pulhin, J.M. and L.V. Tibig. (2014). *Changing Philippine Climate. Impacts on agriculture and natural resources*. Diliman, Quezon City: University of the Philippines Press.
- Food and Agriculture Organization. (2006). *Livestock's Long Shadow. Environmental Issues and Options*. Retrieved from: <http://ftp.fao.org/docrep/fao/010/a0701e/a0701e.pdf>

- Food and Agriculture Organization. (2011). APFIC/FAO Regional consultative workshop “Implications of climate change on fisheries and aquaculture: challenges for adaptation and mitigation in the Asia-Pacific Region” 24–26 May 2011, Kathmandu, Nepal. FAO Regional Office for Asia and the Pacific, Bangkok, Thailand. RAP Publication2011/17, 52 pp.
- FAO. (2014). The State of World Fisheries and Aquaculture. Rome: FAO.
Food and Agriculture Organization of the United Nations. (2014, August 31). FAO Fisheries & Aquaculture - Fishery and Aquaculture Country Profiles - The Republic of the Philippines. Retrieved from Food and Agriculture Organization: <http://www.fao.org/fishery/facp/PHL/en>
- Grace D, Bett B, Lindahl J, and Robinson T. (2015). Climate and livestock disease: assessing the vulnerability of agricultural systems to livestock pests under climate change scenarios. CCAFS Working Paper no. 116. Copenhagen, Denmark. CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). Retrieved from: <http://www.ccafs.cgiar.org>
- Hall, D. C., Ehui, S. and C. Delgado. (2004). The livestock revolution, food safety and small-scale farmers: why they matter to us all. *Journal of Agricultural and Environmental Ethics*. Volume 17, Issue 4-5, pp 425-444.
- ILRI (International Livestock Research Institute). (2000). Livestock Strategy to 2010: Making the Livestock Revolution Work for the Poor. ILRI (spell out), Nairobi, Kenya.
- International Fund for Agricultural Development (IFAD). (2009). Livestock and Climate Change. Livestock Thematic Papers. Tools for Project Design. Retrieved from: <https://www.ifad.org>.
- Jacinto, M. R., Songcuan, A. J., Yip, G. V., & Santos, M. (2015). Development and Application of the Fisheries Vulnerability Assessment Tool (Fish Vool) to Tuna and Sardine Sectors in the Philippines. *Fisheries Research* , 174-181.
- Lansigan, F., and Salvacion, A. (2007). Assessing the effect of climate change on rice and corn yields in selected provinces in the Philippines. 10th National Convention on Statistics , p. 12
- Marine Environment and Resources Foundation, (MERF). (2013). Vulnerability Assessment Tools for Coastal Ecosystems: A Guidebook. Quezon City, Philippines: MERF, Inc. pp 161.
- Perez, M.L., Sajise, A.J.U., Ramirez, P.J.B., Arias, J.K.B., Purnomo, A.H., Dipasupil, S.R., Regoniell, P.A., Nguyen, K.A.T., Zamora, G.J. (2013). Economic Analysis of Climate Change Adaptation Strategies in Selected Coastal Areas in Indonesia, Philippines and Vietnam. Lessons Learned Brief: 2013-33 Penang, Malaysia: WorldFish.
- Perez, R. (No Date). Assessment of Vulnerability and Adaptation to Climate Change in the Philippines Coastal Resources Sector. Quezon City: Natural Disaster Reduction Branch, Philippine Atmospheric, Geophysical and Astronomical Services Administration (unpublished).

- Perez, R., Amadore, L., & Feir, R. (1999). Climate Change Impacts and Responses in the Philippine Coastal Sector. *Climate Research* , 97-107.
- Philippine Statistics Authority. (2014). *Fisheries Statistics of the Philippines 2011-2013*. Quezon City: PSA-BAS.
- Philippine Statistics Authority (PSA). (2015). *Selected Statistics on Agriculture 2015*. Quezon City.
- Republic Act (R.A.) 9729. Climate Change Act of 2009. Retrieved from: <http://www.climate.gov.ph/images/docs/RA9729%20CC%20Act%20of%202009.pdf>
- Reyes, S., & Blanco, A. (25 August-01 September, 2012). Assessment of Coastal Vulnerability to Sea Level Rise of Bolinao, Pangasinan Using Remote Sensing and Geographic Information Systems. XXII ISPRS Congress. Melbourne, Australia.
- Sajise, P., Saguiguit, G. J., and Ticsay, M. (2010). *Moving Forward: Southeast Asian Perspectives on Climate Change and Biodiversity*. Singapore: ISEAS Publishing.
- Thornton, P.K., J. van de Steeg, A. Notenbaert, and M. Herrero. (2008). ILRI Research in Relation to Climate Change. Discussion Paper No. 1. Retrieved from: www.ilri.org/infoserv/webpub/full/docs/DiscuPaper11_Climate/Livesto_Climate_Pover_Nexus_DP11.pdf
- United Nations. (2004). *World Population to 2300*. New York: United Nations Publications.
- United Nations. (2015). 17 Sustainable Development Goals. 17 Partnerships. Division for Sustainable Development. United Nations Department of Economic and Social Affairs. Retrieved from: <https://docs.google.com/gview?url=http://sustainabledevelopment.un.org/content/documents/211617%20Goals%2017%20Partnerships.pdf&embedded=true>
- United Nations Framework Convention on Climate Change. (2012). Livestock production and climate change. Submission to the UNFCCC Subsidiary Body for Science and Technological Advice (SBSTA) consultation on livestock and climate change from the World Society for the Protection of Animals. Retrieved from: <http://unfccc.int/resource/docs/2012/smsn/ngo/194.pdf>
- Wikipedia. (2015). List of countries by Green House Gas emission. Retrieved from: https://en.wikipedia.org/wiki/List_of_countries_by_greenhouse_gas_emissions
- World Bank. (2013). 8 of 10 Filipinos Experience Impacts of Climate Change. Retrieved from: <http://www.worldbank.org/en/news/press-release/2013/06/20/survey-8-of-10-Filipinos-Personally-Experience-Impacts-of-Climate-Change>
- World Resources Institute. (2014). Climate Analysis Indicators Tool (CAIT) Climate Data Explorer Retrieved from: [http://cait.wri.org/historic/Country%20GHG%20Emissions?indicator\[\]=Total%20GHG%20Emissions%20Excluding%20Land-Use%20Change%20and%20Forestry&indicator\[\]=Total%20GHG%20Emissions%20Including%20Land-Use%20Change%20and%20Forestry&year\[\]=2011&chartType=geo](http://cait.wri.org/historic/Country%20GHG%20Emissions?indicator[]=Total%20GHG%20Emissions%20Excluding%20Land-Use%20Change%20and%20Forestry&indicator[]=Total%20GHG%20Emissions%20Including%20Land-Use%20Change%20and%20Forestry&year[]=2011&chartType=geo)

ABOUT BAR

The Bureau of Agricultural Research (BAR) is one of the staff bureaus of the Department of Agriculture (DA) which was established to lead and coordinate the national agriculture and fisheries research and development (R&D) in the country. It envisions “a better life for Filipinos through excellence in agriculture and fisheries research and development” with a mission of attaining food security and reducing poverty through technology-based agriculture and fisheries sector. BAR is committed to consolidate, strengthen, and develop the agriculture and fisheries R&D system for the purpose of improving its effectiveness and efficiency by ensuring customer satisfaction and continuous improvement through work excellence, teamwork and networking, accountability and innovation.

Bureau of Agricultural Research
RDMIC Building, Visayas Ave.
cor. Elliptical Road, Diliman
Quezon City, Philippines 1101
Tel. Nos: +63 2 928-8505, 920-0205, 920-0234
Fax: +63 2 927-5691





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Bureau of Agricultural Research
RDMIC Building, Visayas Ave.
cor. Elliptical Road, Diliman
Quezon City, Philippines 1101
Tel. Nos: +63 2 928-8505, 920-0205, 920-0234
Fax: +63 2 927-5691



<http://www.bar.gov.ph>



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