FAO Investment Centre/CFIB

"Adapting Philippine Agriculture to Climate Change." Ex-Ante Cost-Benefit Analysis.

Annex 3

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1. Introduction

1.1. The Economic Context

In the past decade or so, the Philippine economy has progressed in delivering inclusive growth, as outlined by a decline in poverty rates and its Gini coefficient. Poverty decreased from 23.3 percent in 2015 to 16.6 percent in 2018, while the Gini coefficient declined from 44.9 to 42.7 over the same period[1]. However, a significant decrease in this promising economic performance has been seen due to the impact of the COVID-19 pandemic. It is already visible that a slowdown in trade, investment, tourism, and remittances has started to take its toll on the Filipino economy. Fiscal constraints are also being encountered, with most government agencies already experiencing or expecting considerable budget cuts.[2]

While Filipino agriculture has greatly underperformed, it is still seen as having high potential. The sector's contribution to GDP declined from 13.3 percent in 1998 to 8.5 percent in 2017[3], and its annual growth rate was much lower than other Southeast Asian countries. In 2019, the sector employed around 9.7 million people and contributed 23 percent to the country's total employment (WBG, 2020).[4]

The country's vulnerability to natural disasters, a policy focus on rice self-sufficiency, the weakness of institutions that support agriculture (e.g., extension services), and uncertainties generated by a lengthy and unfinished agrarian reform process hampered investment and growth in the agriculture sector. These factors have inhibited the agriculture sector's contribution to economic growth, job creation, and poverty reduction.

While in recent years, the Philippines managed to reduce overall poverty, it remains high in rural areas, where vulnerability to natural hazards, including weather and climate change-related calamities (e.g., typhoons, droughts, heavy rains), persists.

Around 75% of Filipinos live in rural areas where poverty rates are three times higher than in urban areas. Rural poverty rates are particularly considerable in Indigenous Peoples (IPs) and especially acute among IPs in conflict areas, where they can be as high as 68%.

The post-Covid-19 economic growth is expected to rebound gradually (albeit partially) in 2022 after the Philippines' worst recession since World War II experienced in 2020 as global conditions improve, and with more robust domestic activity bolstered by the public investment momentum and an expected boost from 2022 election-related spending. However, it is also anticipated that the economic

[1] As per the World Bank website: https://www.worldbank.org/en/country/philippines/overview#1
[2] Source: https://cpbrd.congress.gov.ph/2012-06-30-13-06-51/2012-06-30-13-36-54/1246-bvt2020-budget-comparison-tables-2020-adjusted-spending-program-2021-proposed-budget
[3] As per World Bank's SPLIT PAD: https://projects.worldbank.org/en/projects-operations/document-detail/P172399?type=projects
[4] As per: https://data.worldbank.org/indicator/SL.AGR.EMPL.ZS?locations=PH

recovery will remain relatively modest due to the ongoing COVID-19 problems associated with slow vaccination campaigns and the government's inability to contain the pandemics.[5]

1.2. The Climate Vulnerability Context

The Philippines, due to its geographical location and archipelago nature of country with highly variable agroecological zones, is exposed to weather and climate-change-related impacts: sea-level rise, increased frequency of extreme weather events (e.g., droughts, typhoons), rising temperatures, and excessive rainfall. Agriculture is primarily rain-fed, therefore, very vulnerable to climate change (CIAT and WFP, 2021).[6]

The country is situated in the world's most cyclone-prone region, averaging 19–20 cyclones each year, of which 7–9 make landfall. Climate change is expected to further increase the onset of weather-related disasters and lead to more intense typhoons, higher sea levels, storm surges, and sudden onsets of droughts. Also, warming oceans and ocean acidification are expected to affect coral reefs, which serve as feeding and spawning grounds for many fish species that support fisher folks' livelihoods. According to the Philippines Statistical Authority (PSA), the monetary damage from the onset of natural disasters accounted for around USD 9 billion from 2010-to 2019. The 63% of this estimated amount was attributed to the damage to agriculture.[7]

The Climate Risk Index (CRI) outlines the level of exposure and vulnerability to extreme weather events (e.g., storms, heatwaves, etc.) and associated loss (death toll, material losses, etc.). In its 2020 estimates, the CRI placed the Philippines in second place among the top ten most seriously weather-affected countries in 2018[8], outlining the gravity and seriousness of the situation and worrying potential for future weather and climate-related calamities.

Climate-related impacts are expected to reduce agricultural productivity and bring more production-related risks to Filipino farmers. It is anticipated that agricultural productivity will decline by 9% by 2050 due to various meteorological and climatological disasters.[9] While it is not possible in the short-run to stop the chain of weather and climate-related disastrous events, it is expected that the increase in risk experienced by farmers can be managed through various methods: improved access to timely predictions of changing weather and onset of typhoons (e.g., via modernization of data collecting weather stations and timely data flow to farmers), adoption of improved farming techniques (e.g., Sloping Agriculture Land Technology

[5] As per the full report from: https://country.eiu.com/philippines
[6] Source : https://www.wfp.org/publications/2018-fill-nutrient-gap-philippines-summary-report
[7] Source: PSA, 2020.
[8] As per: https://www.germanwatch.org/en/17307
[9] Source: https://doi.org/10.1007/978-4-431-55078-5_12

(SALT), crops rotation, organic production, etc.), or better water management (e.g., rainwater harvesting, alternate wetting and drying in the case of rice production), to name a few.

1.3. The Adaptation to Climate Change Grant Proposal

The ex-ante CBA presented in this annex and accompanying CBA Excel models that have been prepared in support of the Green Climate Fund (GCF) proposal: *Adapting Philippine Agriculture to Climate Change* aim to show how the requested grant-funding could potentially impact the incomes and livelihoods of Filipino farmers in agri.-ecological zones targeted in this proposal. The training and other agriculture-related support associated with the grant funding could minimize the weather and climate-related risks of Filipino small-scale farmers and facilitate their adaptation to climate change through increased adoption of climate-resilient agriculture (CRA) strategies to support their incomes and food security in the years to come.

Filipino agricultural production is mainly rain-dependent since the irrigation and drainage infrastructure remains absent or suboptimal. The traditional farming practices that concentrate on monocultural agricultural production are characteristic of small-scale Filipino farmers. These farmers are expected to be particularly affected by changing climate if they do not learn and adopt CRA strategies.

The climate change effects, especially the predicted inter-zonal and temporal variations in the volume and frequency of rainfall across the Philippine archipelago, will expose farmers to income changes over time. The less predictable rains and consequential periods of longer-lasting droughts or more prevalent onsets of floods will influence agricultural yields of multiple commodities, hence the incomes of farmers in various agri.-ecological zones.

While the immediate effects of extreme weather events differ from the weather variations associated with the longer-run climate change, it is expected that the intensity of severe weather will increase in tandem with the changing climate. Consequently, Filipino farmers will become more exposed and vulnerable to material and agricultural production damage caused by sudden and disastrous weather events.

There exist multiple CRA strategies that Filipino farmers could adopt to reduce their vulnerability to climate change and extreme weather events. Increased use of more stress-tolerant rice and corn varieties, wider use of natural and commodity-suitable fertilizers in situ of chemical fertilizers, simultaneous planting of different commodities (intercropping), or annual crops rotation are critical for adapting to both flooding and drought (as well as salinity in some coastal areas). Practices such as alternate wetting and drying reduce water consumption, help adapt to reduced precipitation and contribute to reducing methane emissions. Integrated sloping land agriculture technology (SALT) is a critical practice for corn, coconut, and upland

crops. Integrated SALT improves soil composition and stability by layering cropping systems to better harness water in drought conditions, reduce the impacts of heavy rainfalls, and provide increased shelter from strong wind. Vegetable shelters and small water harvesting systems (e.g., watershed management integrated with indigenous food production systems) might also be necessary for upland crops and farming systems.

In the analysis outlined in this annex, a set of indicative interventions was established for preselected five agri.-ecological zones. Consequently, seven indicative types of Climate Resilient Agriculture (CRA) enterprises (as described in Table 1) were developed to forecast potential gains for Filipino farmers targeted by CRA enterprise development interventions funded through the GCF grant. These seven scenarios were appraised using the standard ex-ante CBA methodology (see Section 2 for more methodological details).

The primary role of interventions that will help set up these CRA enterprises is to provide an improved organization of individual farmers that will help leverage better prices for agricultural outputs due to a higher combined volume of production. It is expected that farmers organized in CRA enterprises will be able to shorten the value chain and sell their agriculture outputs directly, without using intermediaries. This, in turn, will result in their ability to obtain higher prices for their products in the market. Consequently, the development progress will be realized through: (i). Farmers' incomes increase realized due to the reduction in agricultural losses associated with changing climate, higher probability of disastrous weather events, and suboptimal agricultural practices (due to the adoption of improved CRA practices), (ii). Farmers' incomes increase caused by a rise in prices of outputs (due to a higher combined volume of outputs that will allow selling directly, without the involvement of intermediaries).

Additional analysis was pursued to outline potential other measurable gains associated with the delivery of training, peer learning, and consequential and expected adoption of similar practices to the ones described in the seven CRA enterprise scenarios by other farmers. This analysis used incremental financial and economic results obtained from the individual (per 1 ha/1 farmer-beneficiary) ex-ante CBA analysis of mentioned CRA enterprises. The potential adoption rates among other farmers exposed to CRA learning and expected to benefit from this grant were used to deliver anticipated incremental financial and economic gains. For the results of this analysis, please refer to section 5.3 below.

2. Methodology

The methodology used in this analysis was formulated using the classic Cost-Benefit Analysis (CBA) framework. The modeling and analytical approach was largely based on the *"Cost-Benefit Analysis for Investment Decisions"* by Glenn P. Jenkins, Chun-Yan Kuo, and Arnold Harberger, 2018.[10]

2.1. Step 1: Choice of Intervention and Construction of Scenarios

The first step of the ex-ante CBA involved the construction of seven[11] "Without Project Scenarios (WOP)" and "With Project (WP)" scenarios that were assessed later using Steps 2-4 (described in proper subsections below). The scenarios were created based on the available feasibility study, desktop research, experts' suggestions, and past research trips, including interviews with farmers in various areas of the Philippines. The scenarios created seven indicative types of CRA enterprises and included a subset of suggested interventions in five agroecological zones of the Philippine archipelago that were listed as specifically prone to weather and climate-related calamities. The appraised CRA enterprise scenarios are presented in detail in Table 1 below.

2.2. Step 2: Financial Analysis

The second step of the analysis consisted of the construction of three different sets of financial cash flows.

Firstly, the "Without Project" (WOP) financial cash flows (one for each modeled CRA enterprise) were created. Each WOP cash flow included tracing down all expected costs and revenues that would accrue to farmers under the WOP scenario. The data used for creating these scenarios came from multiple sources: desktop research including literature reviews, consulting of PSA data, previous interviews with Filipino farmers, and data from FAO, World Bank, and International Monetary Fund (IMF).

Then, the "With Project" (WP) financial cash flows separately for each of the proposed CRA enterprises were developed. These cash flows traced down all potential costs and revenues that are expected to accrue to beneficiaries once specific interventions are put in place (as per interventions described in Table 1 below).

[10] The first edition of this book published by Cambridge Resources International Inc. was used.
[11] Please note: In reality, the ex-ante CBA contains nine CRA enterprises as enterprises 2 and 3 were additionally developed into CRA enterprises 2B and 3B that used the same agriculture production assumptions plus additional loan funding from the Land Bank.

Lastly, the incremental financial cash flows that show the difference between the individual WOP and each of the WP scenarios were developed separately for each CRA enterprise-type.

As a result, standard measures of the project's financial profitability and viability were estimated for each CRA enterprise: Financial Net Present Values (FNPV), Financial Internal Rates of Return (FIRR), and Modified Internal Rates of Return (MIRR). [12]

The analysis was pursued in individual terms (per 1 ha of farmland/per individual farmer-beneficiary) and in aggregate terms, for assumed number of hectares (assumed number of farmers-beneficiaries), as described in Table 2 below.[13]

2.3. Step 3: Economic Analysis and Conversion Factors

In the third step of the analysis, all financial cash flows were adjusted to their economic values using a set of self-calculated Conversion Factors (CFs). The individual and aggregate economic flows of resources include Greenhouse Gas Emissions (GHG) costing (carbon valuation) to account for potential environmental impacts. Standard project's economic sustainability measures Economic Net Present Values (ENPV), Economic Rates of Return (ERR), and Economic Modified Internal Rates of Return (EMIRR) were estimated to show economic profitability of proposed interventions. [14]

The incremental economic analysis was also pursued to show the incremental benefits from proposed interventions. The incremental analysis remains at the core of the CBA. Its results are the most important to show if the project's proposed interventions are likely to bring measurable benefits to the project's beneficiaries and the entire economy. The incremental results are calculated by netting out WOP scenario from the WP scenario, separately for each intervention and they are pursued in the case of financial and economic analysis.

[12] Please note: The financial analysis results **do not include** the valuation of GHG emissions (carbon valuation).
[13] Please note: The assumption about the potential number of hectares that could be put into CRA strategies described in each scenario was necessary to establish potential aggregate benefits that could be attributed to individual scenarios/interventions. Since the project envisions 1.25 million direct beneficiaries and assuming an average HHS size of 5 people and an average land holding of 1 ha/per HHs. CRA enterprises 2B and 3B should not be added to these total estimated aggregate hectares. They were prepared additionally to showcase how the results obtained in scenarios 2 and 3 would differ if farmers received additional loan funding from the Land Bank.
[14] Please note: The economic analysis results **include** the valuation of GHG emissions (carbon valuation).

2.4. Step 4: Sensitivity Analysis: "What if" Analysis

In the final step, a sensitivity analysis was pursued. To make the CBA estimates more dynamic, several "what if" scenarios were developed and analyzed to see how the incremental financial and economic NPVs, MIRRs, and IRRs might be influenced when some of the most important variables change. The created scenarios aimed at assessing the riskiness of some of the proposed interventions when a single variable (e.g., loss in yield, price of fertilizer, etc.) is moved from its original value.

The sensitivity analysis also estimated the standard CBA measures (incremental): FNPVs, FIRRs, MIRRs, ENPVs, EIRRs, EMIRRs associated with each of the proposed interventions' potential adoption rates in each agroecological zone of interest.

3. Proposed Interventions

The set of interventions that aim at creating seven CRA enterprises and were assessed in this CBA is presented in detail in Table 1 below. The evaluated interventions were selected based on the available feasibility study and fined tuned to fit Philippine agroecological zones that are mentioned as the most prone to weather and climate-related calamities and are of interest for the proposed grant funding: Cordillera Autonomous Region (CAR), Luzon, Cagayan Valley, Visayas, Bicol, Bukidnon, and SOCCSKARGEN.

In the ex-ante CBA, it was assumed that these seven types of CRA enterprises will be established on a combined total of 250,000 hectares (ha) and will directly benefit 250,000 of farmers which will be equivalent to 1,250,000 people (assuming average household (HH) of 5 people). For more details regarding the distribution of CRA enterprises-types per agri.-ecological zone, please refer to Table 2 below.

Table 1. Assessed Interventions/CRA enterprises.

Table 1.								
CRA Enterprise Type	**Region**	**Intervention**	**Intervention: Introduction of CRA Practice**	**Agroecological Zone of Intervention**	**"Without Project" (WOP) Scenario**	**"With Project" (WP) Scenario**	**Expected Adaptation to Climate Change due to Proposed Intervention**	**Expected Gains to Beneficiaries**
CRA enterprise type 1	**Cordillera Autonomous Region (CAR) and Luzon**	**Intervention 1 (models based on CAR specifics)**	Introduction of blight resistant white potatoes-green cabbage crops rotation and construction of rainwater harvesting tank for irrigation purposes.	Benguet, Mountain Province, Luzon	Conventional white potatoes monocropping using inbred potatoes cultivars and no rainwater harvesting for irrigation. Two rotations per year are assumed.	White potatoes and green cabbage rotation using potatoes Blight Resistant cultivars (like Igorota BSU PO4, for example). Construction of rainwater harvesting system for irrigation. Consequently, cultivation of green cabbage and white potatoes in the irrigated production system.	Adaptation to droughts, typhoons, and onsets of potatoes diseases.	Lower risk of yield loss due to droughts, typhoons, and potatoes disease. Potentially lower risk of crop failure due to diversification of production through crops rotation.
CRA enterprise type 2	**Cordillera Autonomous Region (CAR) and Visayas**	**Intervention 2 (models based on CAR specifics)**	Introduction of rice-onion crops rotation with early maturing rice cultivars.	CAR: Abra, Ifuago, Kalinga, Mountain Province; Visayas	Production of conventional rice (monocropping). Two rotations per year are assumed.	Rice-onion crops rotation using early maturing rice cultivars (conventional crops production). One rotation of each commodity per year is assumed.	Adaptation to droughts. Expected increase in soil health due to intercropping with onion. This rotation cropping scheme aims at utilizing the remaining nutrients from the rice field at the same time interrupting the cycle of plant pathogens and insect pests in rice-based farming system.	Lower risk of yield loss due to droughts, typhoons, increased income due to onion production. Potential decrease in fertilizer costs due to intercropping. Gain in income from onion cultivation in the second rotation in the same year.
CRA enterprise type 2B (The same as CRA enterprise 2 but with additional Landbank loan assumed)	**Cordillera Autonomous Region (CAR) and Visayas**	**Intervention 2B (models based on CAR specifics)**	Introduction of rice-onion crops rotation with early maturing rice cultivars.	CAR: Abra, Ifuago, Kalinga, Mountain Province; Visayas	Production of conventional rice (monocropping). Two rotations per year are assumed.	Rice-onion crops rotation using early maturing rice cultivars (conventional crops production). One rotation of each commodity per year is assumed. Increased production (planting area and potential yield) due to additional funding.	Adaptation to droughts. Expected increase in soil health due to intercropping with onion. This rotation cropping scheme aims at utilizing the remaining nutrients from the rice field at the same time interrupting the cycle of plant pathogens and insect pests in rice-based farming system.	Lower risk of yield loss due to droughts, typhoons, increased income due to onion production. Potential decrease in fertilizer costs due to intercropping. Gain in income from onion cultivation in the second rotation in the same year.

Table 1.

CRA Enterprise Type	Region	Intervention	Intervention: Introduction of CRA Practice	Agroecological Zone of Intervention	"Without Project" (WOP) Scenario	"With Project" (WP) Scenario	Expected Adaptation to Climate Change due to Proposed Intervention	Expected Gains to Beneficiaries
CRA enterprise type 3	**North-East Luzon (Cagayan Valley) and Visayas**	**Intervention 3 (models based on Cagayan Valley specifics)**	Introduction of yellow corn-peanuts (groundnuts) rotation with drought resistant yellow corn cultivars. Additional introduction of Sloping Agricultural Land Technology (SALT).	Cagayan, Isabela, Visayas	Production of conventional yellow corn (monocropping). Two rotations per year are assumed.	Yellow corn-peanuts crops rotation (conventional crops) with high yielding yellow corn cultivars and SALT technology. One rotation of each commodity per year is assumed.	Adaptation to droughts, typhoons, and increase in soil fertility. Expected decrease in soil erosion due to SALT. Expected positive spillover effect to biodiversity due to potentially lower usage of chemical fertilizers caused by intercropping with nitrogen fixating peanuts.	Lower risk of yield loss due to droughts, typhoons, improved soil health, increase in income due to peanuts production, decrease in costs of fertilizer due to nitrogen fixating abilities of peanuts.
CRA enterprise type 3B (The same as CRA enterprise 3 but with additional Landbank loan assumed)	**North-East Luzon (Cagayan Valley) and Visayas**	**Intervention 3B (models based on Cagayan Valley specifics)**	Introduction of yellow corn-peanuts (groundnuts) rotation with drought resistant yellow corn cultivars. Additional introduction of Sloping Agricultural Land Technology (SALT).	Cagayan, Isabela, Visayas	Production of conventional yellow corn (monocropping). Two rotations per year are assumed.	Yellow corn-peanuts crops rotation (conventional crops) with high yielding yellow corn cultivars and SALT technology. One rotation of each commodity per year is assumed. Increased production (planting area and potential yield) due to additional funding.	Adaptation to droughts, typhoons, and increase in soil fertility. Expected decrease in soil erosion due to SALT. Expected positive spillover effect to biodiversity due to potentially lower usage of chemical fertilizers caused by intercropping with nitrogen fixating peanuts.	Lower risk of yield loss due to droughts, typhoons, improved soil health, increase in income due to peanuts production, decrease in costs of fertilizer due to nitrogen fixating abilities of peanuts.
CRA enterprise type 4	**North-Eastern Luzon (Cagayan Valley)**	**Intervention 4 (models based on Cagayan Valley specifics)**	Introduction of organic rice cultivation (2 rotations per year) with alternate wetting and drying irrigation-System of Rice Intensification (SRI).	Cagayan, Isabela	Production of conventional rice (monocropping). Two rotations per year are assumed.	Production of rice using organic rice production (monocropping). Two rotations per year are assumed. Introduction of alternate wetting and drying-System of Rice Intensification (SRI).	Adaptation to droughts, typhoons, and increase in soil fertility due to switch to organic rice cultivation. Expected increase in biodiversity due to no use of chemical fertilizers. Lower usage of water in rice production. Reduction in flooding of paddy fields, hence, potentially lower methane emissions. Because SRI relies on keeping the field soil moist, rather than saturated, it reduced irrigation water use roughly by 50%. This creates aerobic conditions in the soil which inhibit populations of methane-producing organisms, reducing the carbon-footprint of the farming.	Lower risk of yield loss due to droughts, typhoons, and decrease in costs of fertilizers due to organic production. Potential gain in income due to higher prices of organic rice.

Table 1.

CRA Enterprise Type	Region	Intervention	Intervention: Introduction of CRA Practice	Agroecological Zone of Intervention	"Without Project" (WOP) Scenario	"With Project" (WP) Scenario	Expected Adaptation to Climate Change due to Proposed Intervention	Expected Gains to Beneficiaries
CRA enterprise type 5	**Eastern Seaboard: Bicol**	**Intervention 5 (models based on Bicol specifics)**	Coconuts-bananas intercropping	Camarines Sur, Camarines Norte	Coconuts monocropping	Coconuts-bananas intercropping.	Adaptation to onsets of typhoons, heavy winds, and drought.	Lower risk of yield loss due to droughts, winds and typhoons. Additional income from bananas.
CRA enterprise type 6	**Mindanao: Bukidnon**	**Intervention 6 (models based on Bukidnon specifics)**	Intercropping of coffee with peanuts (groundnuts) and Sloping Agricultural Land Technology (SALT) for Robusta coffee production	Bukidnon	Robusta coffee monocropping	Robusta coffee intercropping with peanuts (groundnuts) and SALT.	Adaptation to onsets of droughts, heavy rains, winds, and typhoons. Expected decrease in soil erosion and increase in soil fertility due to intercropping with peanuts (groundnuts).	Lower risk of yield loss due to typhoons and winds. Healthier soil due to nitrogen fixation of peanuts (groundnuts). Lower soil erosion due to SALT.
CRA enterprise type 7	**Mindanao: SOCCSKARGEN**	**Intervention 7 (models based on SOCCSKARGEN specifics)**	Introduction of cocoa -coconuts intercropping (organic production)	North Cotabato	Coconuts monocropping	Organic coconuts and cocoa intercropping.	Adaptation to onsets of typhoons, heavy winds, and droughts.	Lower risk of yield loss due to droughts, typhoons, and heavy winds. Additional income from production of cocoa.

4. Assumptions

The ex-ante nature of the estimated CBA models required a set of assumptions that helped develop and appraise the benefits of proposed CRA enterprises. These assumptions are divided into two categories: general and macroeconomic assumptions common to all CBA models (e.g., inflation rate, exchange rate, etc., as outlined in Table 2 below) and model-specific assumptions relevant to each of the estimated CBA models (included in the accompanying Excel sheets). Both types of assumptions are discussed in the next two subsections, respectively.

4.1. General and Macroeconomic Assumptions

The non-exhaustive set of general and macroeconomic assumptions used in this CBA modeling is presented in Table 2 below.

Table 2. General and Macroeconomic CBA Models' Assumptions.

Item	Value[15]
Project Implementation Period	7 years
Ex-ante CBA analytical period for cash flows	20 years
Total expected number of direct project's beneficiaries	1.25 million people
Average Filipino Household (HH) Size	5 people
Average land holding per HH	1 ha
Expected number of hectares and farmers-beneficiaries[16] under specific interventions, per CRA enterprise type. These are direct beneficiaries included in CRA enterprise development and assessed directly in the ex-ante CBA. Results of this analysis are presented in Section 5.1 below.	CRA enterprise type 1: 30,000 ha - Region: CAR CRA enterprise type 2: 35,000 ha - Region: CAR CRA enterprise type 3: 32,500 ha - Region: Cagayan Valley CRA enterprise type 4: 32,500 ha - Region: Cagayan Valley CRA enterprise type 5: 50,000 ha – Region: Bicol CRA enterprise type 6: 35,000 ha – Region: Northern Mindanao

[15] Assumptions are based on the information from the following sources: PSA, World Bank, Bangko Sentral ng Pilipinas, Bureau of Internal Revenue Republic of the Philippines, National Economic Development Agency (NEDA). Additionally, all potential subsidies were assumed away due to the lack of precise data. More details regarding assumptions used in the modeling process can be seen in the accompanying Excel sheets with models.

[16] Note: It is assumed that 1 farmer possesses 1 ha of land. The average landholding in the Philippines is 1.3 ha (as per PSA, 2015 Census). One hectare was used to remain conservative.

Item	Value[15]
	CRA enterprise type 7: 35,000 ha – Region: SOCCSKARGEN **Total: 250,000 ha (or farmers) - equivalent to 1.25 million HHs member beneficiaries** (250,000*5 HH members=1,250,000 HH members)
Philippine Inflation Rate	3.00%
US Inflation Rate	2.30%
PHP to USD exchange rate	52.00 PHP=1 USD
General VAT level	12%
VAT on agric. inputs like seeds, for example	0%
Financial Discount Rate	10%
Economic Discount Rate (Economic Opportunity Cost of Capital (EOCK)	10%

4.2. Model-Specific Assumptions

The specifics regarding the individual intervention/CBA model assumptions can be seen in the accompanying Excel file and are not presented here in detail due to the complexity of models and the significant number of necessary assumptions that differ per intervention and per WOP, or WP scenarios. For specific numbers, please refer to the Excel sheet "Data and Assumptions." However, in the case of each of seven proposed WOP and WP scenarios, specific care was taken to estimate these models using realistic assumptions on the following:

- Commodities farmgate prices,
- Yield levels,
- Inputs costs and volumes,
- Outputs costs and volumes,
- Yield losses (due to weather-related risks and other pests-related risks),
- Labor costs,
- Packaging costs,
- Etc.

Also, special care was taken to establish types of CRA enterprises that are realistic in their nature. This task was achieved in the first place via using Philippine-specific knowledge obtained during previous missions and interviews with farmers in numerous areas of the Philippines. When necessary, this field knowledge was supplemented with a desktop review of available data and publications relevant to specific interventions and their commodities, including the information and

suggestions presented in the feasibility study. Combining all these information sources was used in the CBA modeling process to input necessary values in developing financial and economic cash flows.

In individual CBA models, all financial and economic cash flows were built on an assumption of 1 ha of farmland devoted to a specific production under specific intervention/CRA enterprise-type. It was assumed that one household (HH) composed on average of 5 family members cultivates 1 ha of land and that such a HH receives one of the seven proposed CRA enterprise interventions[17].

The aggregate results were calculated using the aggregate numbers of beneficiaries (and hectares), as described in Table 2 above. The relaxation of the aggregate levels of adoption rates was done as part of the sensitivity analysis (Table 13 below).

In the case of all scenarios it was assumed that farmers either possess the necessary tools (e.g., shear, bolo, etc.) to pursue on-farm production of selected commodities (after all they already engage in farming), or they will have the ability to purchase these tools (through and additional grant financing obtained from elsewhere), or these tools will be made available through other farmers supporting programs that are already in place (like Department of Agriculture "banner programs"). This assumption was used for two reasons: (i). To simplify the models that are already extensive; (ii). To avoid running into the lack of knowledge on these tools' current availability that needed to be accounted for in WOP scenarios.

Additionally, in the case of CRA enterprises 2B and 3B[18] term loans for farmers-beneficiaries were assumed. In the case of CRA enterprise 2B, a loan of PHP 125,000 was assumed, and its repayment was included in the financial and economic analysis. In the case of CRA enterprise 3B, a loan of PHP 50,000 was assumed, and its repayment was included in the financial and economic analysis. In both cases, 2B and 3B, the loan schedule was established for 4 years, with 20% down payment coming from a farmer, with 12 monthly repayments, one year of grace period, and with an interest rate of 9.5% per annum.[19] The role of showing the scenarios where additional loans were assumed was to provide some more information on how the

[17] As per PSA Census from 2015, the average HH size is 5 members, and the average landholding per HH is 1.3 ha. Here One hectare was used to remain conservative. Source: https://psa.gov.ph/tags/popcen-2015#:~:text=Results%20of%20the%202015%20Census%20of%20Population%20(POPCEN%202015)%20revealed,occupancy%20rate%20of%2092.57%20percent.

[18] Please note: Scenarios 2B and 3B differ from scenarios 2 and 3 only in an assumption of the presence of the loan in the case of scenarios 2B and 3B versus no loan in the case of scenarios 2 and 3. Otherwise these scenarios assume the production of the same commodities and using the same climate smart agriculture approaches. They also assume the same potential number of beneficiaries as it is in the case of scenarios 2 and 3, respectively. Also, scenarios 2B and 3B were created for informative purpose only to establish how the potential loan would affect farmers. These scenarios were not included in the overall distribution of potential acreage of interventions in aggregate results.

[19] Note: There are multiple funding options for farmers in the Philippines and it is not possible to model them all. In this analysis a Land Bank loan for crops production was used with an interest rate of 9.5% per annum. This is a loan crafted for agri-enterprises and livelihood projects.

financial situation of the CRA enterprises could look like if they needed to obtain additional production loans.[20]

The potential impact of weather and climate-related changes and calamities on beneficiaries of proposed interventions was internalized and included in financial cash and economic resource flows via yield loss assumptions (harvest and post-harvest loss combined). The assumed loss values were later a sensitivity analysis subject to see how their changing levels might influence the incremental economic benefits (as per section 5.2 below).[21]

Lastly, the models appraised in this ex-ante CBA assumed that the central interventions would include training of farmers and providing other support related to passing the wisdom about CRA strategies to farmers-beneficiaries organized into CRA enterprises in the selected agri.-ecological zones. The effects of these interventions would, in turn, have measurable impacts on farmers' incomes as modeled in the presented ex-ante CBA and outlined in the results of this analysis.

[20] Note: The additional loans were included in the case of two scenarios/CRA enterprises only to minimize the number of models that is already extensive.

[21] Note: In the modeling process, the potential weather impacts were embedded in assumptions about potential changes in annual yields. For example: higher yield losses were assumed in the WOP scenarios due to the lack of climate smart agricultural approaches and training. Lower yield losses were assumed in the case of WP scenarios, after climate smart approaches are adopted by farmers.

5. CBA Results

5.1. Individual and Aggregate Results[22]

The ex-ante CBA was pursued over 20 years using 10% discount rate,[23] and its results indicate that all proposed interventions and CRA enterprises (including two supplementary models with additional loan funding (CRA enterprise 2B and 3B) will have positive incremental financial and economic benefits.

5.1.1. Financial CBA Results

The financial measures of profitability of the proposed interventions (WP scenarios) are all positive and higher when compared to the WOP scenarios. While the incremental economic measures of the project's sustainability are important from the Philippine economy's perspective, proposed interventions' financial viability is vital to achieving the project's financial viability after funding cedes.

If the interventions in the form of the establishment of CRA enterprises that are co-funded through the GCF grant show positive financial returns over a longer time (here over 20 years), there is a higher chance that the benefits from these interventions will be long-lasting, and farmers-beneficiaries will continue to engage in activities co-funded by the GCF grant after the funding and interventions end.

The results obtained in the financial part of this ex-ante CBA suggest that such financial viability is likely to be achieved as all analyzed interventions show positive and higher than the WOP scenarios financial profitability measures (FNPV, FIRR, and MIRR). The details regarding individual CBA results (financial results) are presented in Tables 3 and 4 below.

[22] Note: The overall aggregate financial and economic results for all CRAs 1-7 are presented in Annex 2.

[23] Note: The same discount rate was used in the financial and economic part of the analysis. The 10% discount rate is suggested by the National Economic Development Authority (NEDA) as the Economic Opportunity Cost of Capital (EOCK). While financial discount rate can be lower than 10% (the latest estimates for the Philippines based on the Weighted Average Cost of Capital (WACC) were suggesting est. 7.5%), a higher discount rate was used to remain conservative. Currently, the world and the Philippines are in the volatile macroeconomic setup, hence the conservative approach. It should be noted that if the financial results calculated using higher discount rate (in this case 10%) are positive and suggest that scenario would be financially profitable, these results will be even more positive and financially encouraging while using lower discount rate (in this case est. 7.5%).

Table 3. Individual Financial CBA Results.

Individual Financial CBA Results per 1 ha/ per 1 farmer-beneficiary/ per CRA enterprise type. Note: These results do not include carbon pricing.							
Individual Results							
CRA enterprise 1	**WOP**	**WP**	**Incremental**	**CRA enterprise 2**	**WOP**	**WP**	**Incremental**
Values in PHP				**Values in PHP**			
FNPV(PHP)	422,140	1,242,034	819,895	FNPV(PHP)	112,987	590,868	477,881
Values in USD				**Values in USD**			
FNPV (USD)	8,118	23,885	15,767	FNPV (USD)	2,173	11,363	9,190
Values in %				**Values in %**			
FIRR (%)	62%	70%	75%	FIRR (%)	49%	69%	76%
MIRR (%)	19%	20%	21%	MIRR (%)	18%	20%	21%
CRA enterprise 3	**WOP**	**WP**	**Incremental**	**CRA enterprise 4**	**WOP**	**WP**	**Incremental**
Values in PHP				**Values in PHP**			
FNPV(PHP)	43,615	122,769	79,154	FNPV(PHP)	112,987	237,739	124,752
Values in USD				**Values in USD**			
FNPV (USD)	839	2,361	1,522	FNPV (USD)	2,173	4,572	2,399
Values in %				**Values in %**			
FIRR (%)	44%	59%	75%	FIRR (%)	49%	58%	69%
MIRR (%)	17%	19%	21%	MIRR (%)	18%	19%	20%
CRA enterprise 5	**WOP**	**WP**	**Incremental**	**CRA enterprise 6**	**WOP**	**WP**	**Incremental**
Values in PHP				**Values in PHP**			
FNPV(PHP)	144,532	218,271	73,739	FNPV(PHP)	93,665	217,519	136,697
Values in USD				**Values in USD**			
FNPV (USD)	2,779	4,198	1,418	FNPV (USD)	1,801	4,183	2,629
Values in %				**Values in %**			
FIRR (%)	47%	50%	60%	FIRR (%)	53%	65%	91%
MIRR (%)	18%	19%	22%	MIRR (%)	19%	20%	21%
CRA enterprise 7	**WOP**	**WP**	**Incremental**	**CRA enterprise 2B**	**WOP**	**WP**	**Incremental**
Values in PHP				**Values in PHP**			
FNPV(PHP)	144,532	437,131	292,598	FNPV(PHP)	112,987	507,795	394,808
Values in USD				**Values in USD**			
FNPV (USD)	2,779	8,406	5,627	FNPV (USD)	2,173	9,765	7,592
Values in %				**Values in %**			
FIRR (%)	47%	52%	59%	FIRR (%)	49%	51%	52%
MIRR (%)	18%	22%	26%	MIRR (%)	18%	19%	20%
CRA enterprise 3B	**WOP**	**WP**	**Incremental**				
Values in PHP							
FNPV(PHP)	43,615	126,952	83,337				
Values in USD							
FNPV (USD)	839	2,441	1,603				
Values in %							
FIRR (%)	44%	46%	48%				
MIRR (%)	17%	19%	21%				

*Note: WOP=without project scenario, WP=with project scenario, Incremental=(WP-WOP)

Table 4. Aggregate Financial CBA Results.

Aggregate Financial Results per assumed number of hectares/ farmers-beneficiaries, per CRA enterprise type, respectively. Note: These results do not include carbon pricing.**							
Aggregate Results							
CRA enterprise 1	**WOP**	**WP**	**Incremental**	**CRA enterprise 2**	**WOP**	**WP**	**Incremental**
Values in '000 PHP				**Values in '000 PHP**			
FNPV(PHP)	12,664,185	37,261,023	24,596,838	FNPV(PHP)	3,954,559	20,680,392	16,725,834
Values in '000 USD				**Values in '000 USD**			
FNPV (USD)	243,542	716,558	473,016	FNPV (USD)	76,049	397,700	321,651
Values in %				**Values in %**			
FIRR (%)	62%	70%	75%	FIRR (%)	49%	69%	76%
MIRR (%)	19%	20%	21%	MIRR (%)	18%	20%	21%
CRA enterprise 3	**WOP**	**WP**	**Incremental**	**CRA enterprise 4**	**WOP**	**WP**	**Incremental**
Values in '000 PHP				**Values in '000 PHP**			
FNPV(PHP)	1,417,494	3,989,990	2,572,496	FNPV(PHP)	3,672,090	7,726,531	4,054,441
Values in '000 USD				**Values in '000 USD**			
FNPV (USD)	27,260	76,731	49,471	FNPV (USD)	70,617	148,587	77,970
Values in %				**Values in %**			
FIRR (%)	44%	59%	75%	FIRR (%)	49%	58%	69%
MIRR (%)	17%	19%	21%	MIRR (%)	18%	19%	20%
CRA enterprise 5	**WOP**	**WP**	**Incremental**	**CRA enterprise 6**	**WOP**	**WP**	**Incremental**
Values in '000 PHP				**Values in '000 PHP**			
FNPV(PHP)	7,226,611	10,913,554	3,686,943	FNPV(PHP)	3,278,279	7,613,154	4,784,391
Values in '000 USD				**Values in '000 USD**			
FNPV (USD)	138,973	209,876	70,903	FNPV (USD)	63,044	146,407	92,008
Values in %				**Values in %**			
FIRR (%)	47%	50%	60%	FIRR (%)	53%	65%	91%
MIRR (%)	18%	19%	22%	MIRR (%)	19%	20%	21%
CRA enterprise 7	**WOP**	**WP**	**Incremental**	**CRA enterprise 2B**	**WOP**	**WP**	**Incremental**
Values in '000 PHP				**Values in '000 PHP**			
FNPV(PHP)	5,058,628	15,299,571	10,240,943	FNPV(PHP)	3,954,559	17,772,825	13,818,266
Values in '000 USD				**Values in '000 USD**			
FNPV (USD)	97,281	294,223	196,941	FNPV (USD)	76,049	341,785	265,736
Values in %				**Values in %**			
FIRR (%)	47%	52%	59%	FIRR (%)	49%	51%	52%
MIRR (%)	18%	22%	26%	MIRR (%)	18%	19%	20%
CRA enterprise 3B	**WOP**	**WP**	**Incremental**				
Values in '000 PHP							
FNPV(PHP)	1,417,494	4,125,931	2,708,437				
Values in '000 USD							
FNPV (USD)	27,260	79,345	52,085				
Values in %							
FIRR (%)	44%	46%	48%				
MIRR (%)	17%	19%	21%				

*Note: WOP=without project scenario, WP=with project scenario, Incremental=(WP-WOP).

** Assumed number of hectares/farmers-beneficiaries per CRA enterprise-type: (i). CRA enterprise 1: 30,000, (ii). CRA enterprise 2: 35,000, (iii). CRA enterprise 3: 32,500, (iv). CRA enterprise 4: 32,500, (v). CRA enterprise 5: 50,000, (vi). CRA enterprise 6: 35,000, (vii). CRA enterprise 7: 35,000.Note: CRA 2B and 3B assumed the same number of beneficiaries as CRA 2 and CRA 3, respectively.

5.1.2. Economic CBA Results

In the case of the economic part of the ex-ante CBA, additional valuation of the GHG emission (carbon valuation) was included in the economic resource flows to show potential carbon co-benefits associated with the introduction of proposed CRA strategies (as per Table 1 above).[24] Two carbon pricing bounds were used: lower and upper carbon pricing, respectively. The carbon pricing levels used in this analysis come from the suggested World Bank shadow carbon pricing.[25] The volume of carbon associated with each proposed CRA enterprise-type was estimated using EX-ACT software.

The change from upper carbon valuation to lower carbon valuation did not change the sign of economic results of the ex-ante CBA. The incremental ENPVs remain positive in all cases. Also, incremental EIRR and EMIRR remain above the economic discount rate equal to the Philippine Economic Opportunity Cost of Capital (10%).[26]

However, depending on the GHG emissions valuation (lower versus upper carbon valuation), the results will differ slightly. While the economic value of carbon co-benefits depends on the carbon price used in the analysis, the incremental ENPV remains positive regardless of the case in all proposed CRA enterprise-types.

CRA enterprise 6 doesn't bring any measurable by EX-ACT tool carbon co-benefits (zero co-benefits).[27] Regardless, this intervention still brings positive incremental financial and economic benefits to farmers-beneficiaries. It can help farmers mitigate potential income loss from Robusta coffee monocropping through additional income from intercropped peanuts.

The results of the economic part of the ex-ante CBA are outlined in Tables 5 and 6 (when using lower bound carbon shadow pricing) and Tables 7 and 8 (when using upper bound carbon shadow pricing).

[24] Note: The valuation of carbon co-benefits was included in the economic part, as per standard methodological approach. The financial prices were adjusted to economic prices using proper CFs and economic resource flows were prepared to estimate measures of economic sustainability of each CRA enterprise-type (ENPVs, EIRRs, and EMIRRs).
[25] For details, please see accompanying Excel file, sheet "EXACT results."
[26] Note: The Economic Opportunity Cost of Capital (EOCK) is known as an economic discount rate. The value of 10% is suggested by the NEDA.
[27] Note: The EX-ACT software is not a perfect tool to estimate all potential carbon co-benefits. In the case of CRA enterprise 6, the estimated zero-carbon co-benefits may not mean that there will be no carbon co-benefits. But rather that currently, the software does not have a built-in option to calculate these co-benefits.

Table 5. Individual (per 1 ha) Economic CBA Results with Lower Bound Carbon Pricing.

Individual Economic CBA Results per 1 ha/ per 1 farmer-beneficiary/ per CRA enterprise type.
Note: These results include lower bound carbon valuation.

Individual Results							
CRA enterprise 1	**WOP**	**WP**	**Incremental**	**CRA enterprise 2**	**WOP**	**WP**	**Incremental**
Values in PHP				**Values in PHP**			
ENPV(PHP)	359,593	982,973	624,322	ENPV(PHP)	5,684	195,807	188,302
Values in USD				**Values in USD**			
EFNPV (USD)	6,915	18,903	12,006	EFNPV (USD)	109	3,766	3,621
Values in %				**Values in %**			
EIRR (%)	52%	57%	60%	EIRR (%)	12%	29%	34%
EMIRR (%)	17%	19%	19%	EMIRR (%)	11%	15%	16%
CRA enterprise 3	**WOP**	**WP**	**Incremental**	**CRA enterprise 4**	**WOP**	**WP**	**Incremental**
Values in PHP				**Values in PHP**			
ENPV(PHP)	5,210	126,821	121,610	ENPV(PHP)	5,684	103,762	99,656
Values in USD				**Values in USD**			
EFNPV (USD)	100	2,439	2,339	EFNPV (USD)	109	1,995	1,916
Values in %				**Values in %**			
EIRR (%)	15%	61%	117%	EIRR (%)	12%	33%	68%
EMIRR (%)	12%	20%	24%	EMIRR (%)	11%	16%	21%
CRA enterprise 5	**WOP**	**WP**	**Incremental**	**CRA enterprise 6**	**WOP**	**WP**	**Incremental**
Values in PHP				**Values in PHP**			
ENPV(PHP)	3,592	122,782	119,190	ENPV(PHP)	1,085	132,983	145,093
Values in USD				**Values in USD**			
EFNPV (USD)	3,591.84	122,782	119,190	EFNPV (USD)	21	2,557	2,790
Values in %				**Values in %**			
EIRR (%)	11%	30%	91%	EIRR (%)	11%	43%	93%
EMIRR (%)	10%	16%	25%	EMIRR (%)	10%	17%	22%
CRA enterprise 7	**WOP**	**WP**	**Incremental**	**CRA enterprise 2B**	**WOP**	**WP**	**Incremental**
Values in PHP				**Values in PHP**			
ENPV(PHP)	3,592	424,225	420,633	ENPV(PHP)	5,684	112,748	105,244
Values in USD				**Values in USD**			
EFNPV (USD)	69	8,158	8,089	EFNPV (USD)	109	2,168	2,024
Values in %				**Values in %**			
EIRR (%)	11%	42%	72%	EIRR (%)	12%	18%	20%
EMIRR (%)	10%	21%	29%	EMIRR (%)	11%	13%	14%
CRA enterprise 3B	**WOP**	**WP**	**Incremental**				
Values in PHP							
ENPV(PHP)	5,210	126,553	121,343				
Values in USD							
EFNPV (USD)	100	2,434	2,334				
Values in %							
EIRR (%)	15%	47%	75%				
EMIRR (%)	12%	20%	24%				

*Note: WOP=without project scenario, WP=with project scenario, Incremental=(WP-WOP).

Table 6. Aggregate Economic CBA Results with Lower Bound Carbon Pricing.

Aggregate Economic CBA Results per assumed number of hectares/ farmers-beneficiaries, per CRA enterprise type, respectively.**
Note: These results include lower bound carbon valuation.

Aggregate Results							
CRA enterprise 1	**WOP**	**WP**	**Incremental**	**CRA enterprise 2**	**WOP**	**WP**	**Incremental**
Values in '000 PHP				**Values in '000 PHP**			
ENPV(PHP)	10,787,793	29,489,203	18,729,655	ENPV(PHP)	198,946	6,853,229	6,590,568
Values in '000 USD				**Values in '000 USD**			
ENPV (USD)	207,458	567,100	360,186	ENPV (USD)	3,826	131,793	126,742
Values in %				**Values in %**			
EIRR (%)	52%	57%	60%	EIRR (%)	12%	29%	34%
EMIRR (%)	17%	19%	19%	EMIRR (%)	11%	15%	16%
CRA enterprise 3	**WOP**	**WP**	**Incremental**	**CRA enterprise 4**	**WOP**	**WP**	**Incremental**
Values in '000 PHP				**Values in '000 PHP**			
ENPV(PHP)	169,333	4,121,668	3,952,335	ENPV(PHP)	184,735	3,372,264	3,238,818
Values in '000 USD				**Values in '000 USD**			
ENPV (USD)	3,256	79,263	76,006	ENPV (USD)	3,553	64,851	62,285
Values in %				**Values in %**			
EIRR (%)	15%	61%	117%	EIRR (%)	12%	33%	68%
EMIRR (%)	12%	20%	24%	EMIRR (%)	11%	16%	21%
CRA enterprise 5	**WOP**	**WP**	**Incremental**	**CRA enterprise 6**	**WOP**	**WP**	**Incremental**
Values in '000 PHP				**Values in '000 PHP**			
ENPV(PHP)	179,592	6,139,112	5,959,519	ENPV(PHP)	37,986	4,654,393	5,078,259
Values in '000 USD				**Values in '000 USD**			
ENPV (USD)	3,454	118,060	114,606	ENPV (USD)	730	89,508	97,659
Values in %				**Values in %**			
EIRR (%)	11%	30%	91%	EIRR (%)	11%	43%	93%
EMIRR (%)	10%	16%	25%	EMIRR (%)	10%	17%	22%
CRA enterprise 7	**WOP**	**WP**	**Incremental**	**CRA enterprise 2B**	**WOP**	**WP**	**Incremental**
Values in '000 PHP				**Values in '000 PHP**			
ENPV(PHP)	125,715	14,847,866	14,722,152	ENPV(PHP)	198,946	3,946,186	3,683,525
Values in '000 USD				**Values in '000 USD**			
ENPV (USD)	2,418	285,536	283,118	ENPV (USD)	3,826	75,888	70,837
Values in %				**Values in %**			
EIRR (%)	11%	42%	72%	EIRR (%)	12%	18%	20%
EMIRR (%)	10%	21%	29%	EMIRR (%)	11%	13%	14%
CRA enterprise 3B	**WOP**	**WP**	**Incremental**				
Values in '000 PHP							
ENPV(PHP)	169,333	4,112,968	3,943,636				
Values in '000 USD							
ENPV (USD)	3,256	79,096	75,839				
Values in %							
EIRR (%)	15%	47%	75%				
EMIRR (%)	12%	20%	24%				

*Note: WOP=without project scenario, WP=with project scenario, Incremental=(WP-WOP).
** Assumed number of hectares/farmers-beneficiaries per CRA enterprise-type: (i). CRA enterprise 1: 30,000, (ii). CRA enterprise 2: 35,000, (iii). CRA enterprise 3: 32,500, (iv). CRA enterprise 4: 32,500, (v). CRA enterprise 5: 50,000, (vi). CRA enterprise 6: 35,000, (vii). CRA enterprise 7: 35,000.Note: CRA 2B and 3B assumed the same number of beneficiaries as CRA 2 and CRA 3, respectively.

Table 7. Individual (per 1 ha) Economic CBA Results with Upper Bound Carbon Pricing.

Individual Economic CBA Results per 1 ha/ per 1 farmer-beneficiary/ per CRA enterprise type.
Note: These results include upper bound carbon valuation.

Individual Results							
CRA enterprise 1	**WOP**	**WP**	**Incremental**	**CRA enterprise 2**	**WOP**	**WP**	**Incremental**
Values in PHP				**Values in PHP**			
ENPV(PHP)	359,593	983,221	624,569	ENPV(PHP)	5,684	211,633	204,129
Values in USD				**Values in USD**			
EFNPV (USD)	6,915	18,908	12,011	EFNPV (USD)	109	4,070	3,926
Values in %				**Values in %**			
EIRR (%)	52%	57%	60%	EIRR (%)	12%	30%	36%
EMIRR (%)	17%	19%	19%	EMIRR (%)	11%	15%	16%
CRA enterprise 3	**WOP**	**WP**	**Incremental**	**CRA enterprise 4**	**WOP**	**WP**	**Incremental**
Values in PHP				**Values in PHP**			
ENPV(PHP)	5,210	144,873	139,663	ENPV(PHP)	5,684	210,592	206,468
Values in USD				**Values in USD**			
EFNPV (USD)	100	2,786	2,686	EFNPV (USD)	109	4,050	3,971
Values in %				**Values in %**			
EIRR (%)	15%	71%	147%	EIRR (%)	12%	62%	245%
EMIRR (%)	12%	21%	25%	EMIRR (%)	11%	20%	29%
CRA enterprise 5	**WOP**	**WP**	**Incremental**	**CRA enterprise 6**	**WOP**	**WP**	**Incremental**
Values in PHP				**Values in PHP**			
ENPV(PHP)	3,592	134,652	131,060	ENPV(PHP)	1,085	132,983	145,093
Values in USD				**Values in USD**			
EFNPV (USD)	69	2,589	2,520	EFNPV (USD)	21	2,557	2,790
Values in %				**Values in %**			
EIRR (%)	11%	32%	109%	EIRR (%)	11%	43%	93%
EMIRR (%)	10%	16%	26%	EMIRR (%)	10%	17%	22%
CRA enterprise 7	**WOP**	**WP**	**Incremental**	**CRA enterprise 2B**	**WOP**	**WP**	**Incremental**
Values in PHP				**Values in PHP**			
ENPV(PHP)	3,592	429,912	426,321	ENPV(PHP)	5,684	128,575	121,070
Values in USD				**Values in USD**			
EFNPV (USD)	69	8,268	8,198	EFNPV (USD)	109	2,473	2,328
Values in %				**Values in %**			
EIRR (%)	11%	42%	74%	EIRR (%)	12%	20%	21%
EMIRR (%)	10%	21%	29%	EMIRR (%)	11%	14%	15%
CRA enterprise 3B	**WOP**	**WP**	**Incremental**				
Values in PHP							
ENPV(PHP)	5,210	144,605	139,395				
Values in USD							
EFNPV (USD)	100	2,781	2,681				
Values in %							
EIRR (%)	15%	54%	96%				
EMIRR (%)	12%	20%	25%				

*Note: WOP=without project scenario, WP=with project scenario, Incremental=(WP-WOP).

Table 8. Aggregate Economic CBA Results with Upper Bound Carbon Pricing.

Aggregate Economic CBA Results per assumed number of hectares/ farmers-beneficiaries**, per CRA enterprise type, respectively. Note: These results include upper bound carbon valuation.							
Aggregate Results							
CRA enterprise 1	**WOP**	**WP**	**Incremental**	**CRA enterprise 2**	**WOP**	**WP**	**Incremental**
Values in '000 PHP				**Values in '000 PHP**			
ENPV(PHP)	10,787,793	29,496,622	18,737,074	ENPV(PHP)	198,946	7,407,161	7,144,500
Values in '000 USD				**Values in '000 USD**			
ENPV (USD)	207,458	567,243	360,328	ENPV (USD)	3,826	142,445	137,394
Values in %				**Values in %**			
EIRR (%)	52%	57%	60%	EIRR (%)	12%	30%	36%
EMIRR (%)	17%	19%	19%	EMIRR (%)	11%	15%	16%
CRA enterprise 3	**WOP**	**WP**	**Incremental**	**CRA enterprise 4**	**WOP**	**WP**	**Incremental**
Values in '000 PHP				**Values in '000 PHP**			
ENPV(PHP)	169,333	4,708,366	4,539,033	ENPV(PHP)	184,735	6,844,228	6,710,782
Values in '000 USD				**Values in '000 USD**			
ENPV (USD)	3,256	90,545	87,289	ENPV (USD)	3,553	131,620	129,053
Values in %				**Values in %**			
EIRR (%)	15%	71%	147%	EIRR (%)	12%	62%	245%
EMIRR (%)	12%	21%	25%	EMIRR (%)	11%	20%	29%
CRA enterprise 5	**WOP**	**WP**	**Incremental**	**CRA enterprise 6**	**WOP**	**WP**	**Incremental**
Values in '000 PHP				**Values in '000 PHP**			
ENPV(PHP)	179,592	6,732,610	6,553,018	ENPV(PHP)	37,986	4,654,393	5,078,259
Values in '000 USD				**Values in '000 USD**			
ENPV (USD)	3,454	129,473	126,020	ENPV (USD)	730	89,508	97,659
Values in %				**Values in %**			
EIRR (%)	11%	32%	109%	EIRR (%)	11%	43%	93%
EMIRR (%)	10%	16%	26%	EMIRR (%)	10%	17%	22%
CRA enterprise 7	**WOP**	**WP**	**Incremental**	**CRA enterprise 2B**	**WOP**	**WP**	**Incremental**
Values in '000 PHP				**Values in '000 PHP**			
ENPV(PHP)	125,715	15,046,935	14,921,221	ENPV(PHP)	198,946	4,500,117	4,237,456
Values in '000 USD				**Values in '000 USD**			
ENPV (USD)	2,418	289,364	286,947	ENPV (USD)	3,826	86,541	81,490
Values in %				**Values in %**			
EIRR (%)	11%	42%	74%	EIRR (%)	12%	20%	21%
EMIRR (%)	10%	21%	29%	EMIRR (%)	11%	14%	15%
CRA enterprise 3B	**WOP**	**WP**	**Incremental**				
Values in '000 PHP							
ENPV(PHP)	169,333	4,699,666	4,530,333				
Values in '000 USD							
ENPV (USD)	3,256	90,378	87,122				
Values in %							
EIRR (%)	15%	54%	96%				
EMIRR (%)	12%	20%	25%				

*Note: WOP=without project scenario, WP=with project scenario, Incremental=(WP-WOP).** Assumed number of hectares/farmers-beneficiaries per CRA enterprise-type: (i). CRA enterprise 1: 30,000, (ii). CRA enterprise 2: 35,000, (iii). CRA enterprise 3: 32,500, (iv). CRA enterprise 4: 32,500, (v). CRA enterprise 5: 50,000, (vi). CRA enterprise 6: 35,000, (vii). CRA enterprise 7: 35,000.Note: CRA 2B and 3B assumed the same number of beneficiaries as CRA 2 and CRA 3, respectively.

5.2. "What-if" Sensitivity Analysis

The pursued sensitivity analysis and the construction of several "what if scenarios" associated with CRA enterprises show that obtained ex-ante CBA results are largely insensitive to changes in the most important variables. Several "what if scenarios" were created to assess if the obtained incremental financial and economic NPVs, MIRRs, and IRRs can be influenced by individual variation in some important variables.

The variables used for sensitivity analysis included increased yield loss for all modeled commodities, increased price of inputs, and decreased price of outputs of all produced commodities in each of the proposed interventions. The "what-if scenarios" took under consideration the changes in each of the tested variables of up to +/-30%. Details are presented in Tables 9 and 10 below.

Table 9. Sensitivity Analysis Results (Incremental Financial Part/Incremental FNPVs).

CRA enterprise	**Sensitized Variables per CRA enterprise**						
CRA enterprise 1	**White potatoes yield loss [+] 10%, 20%, 30%**	**Green cabbage yield loss [+] 10%, 20%, 30%**	**Decrease in price of potatoes [-] 10%, 20%, 30%**	**Decrease in price of green cabbage [-] 10%, 20%, 30%**	**Increase in price of Urea [+] 10%, 20%, 30%**	**Increase in price of Complete [+] 10%, 20%, 30%**	**Increase in price of Potash [+] 10%20%, 30%**
	Positive incremental financial results persist after sensitization up to 30%	Positive incremental financial results persist after sensitization up to 30%	Positive incremental financial results persist after sensitization up to 30%	Positive incremental financial results persist after sensitization up to 30%	Positive incremental financial results persist after sensitization up to 30%	Positive incremental financial results persist after sensitization up to 30%	Positive incremental financial results persist after sensitization up to 30%
CRA enterprise 2	**Rice yield loss [+] 10%, 20%, 30%**	**Onion yield loss [+] 10%, 20%, 30%**	**Decrease in price of rice [-] 10%, 20%, 30%**	**Decrease in price of onion [-] 10%, 20%, 30%**	**Increase in price of Urea [+] 10%, 20%, 30%**	**Increase in price of Complete [+] 10%, 20%, 30%**	**Increase in price of Potash [+] 10%, 20%, 30%**
	Positive incremental financial results persist after sensitization up to 30%	Positive incremental financial results persist after sensitization up to 30%	Positive incremental financial results persist after sensitization up to 30%	Positive incremental financial results persist after sensitization up to 20%. At 30% price decrease financial results turn into negative values.	Positive incremental financial results persist after sensitization up to 30%	Positive incremental financial results persist after sensitization up to 30%	Positive incremental financial results persist after sensitization up to 30%

CRA enterprise	Sensitized Variables per CRA enterprise						
CRA enterprise 3	**Yellow corn yield loss [+] 10%, 20%, 30%**	**Peanuts yield loss [+] 10%, 20%, 30%**	**Decrease in price of yellow corn [-] 10%, 20%, 30%**	**Decrease in price of peanuts [-] 10%, 20%, 30%**	**Increase in price of Urea [+] 10%, 20%, 30%**	**Increase in price of Complete [+] 10%, 20%, 30%**	
	Positive incremental financial results persist after sensitization up to 30%	Positive incremental financial results persist after sensitization up to 30%	Positive incremental financial results persist after sensitization up to 30%	Positive incremental financial results persist after sensitization up to 10%. At 20% price decrease financial results turn into negative values.	Positive incremental financial results persist after sensitization up to 30%	Positive incremental financial results persist after sensitization up to 30%	
CRA enterprise 4	**Rice price [-] 10%, 20%, 30%**						
	At 10% price decrease financial results turn into negative values.						
CRA enterprise 5	**Bananas yield loss [+] 10%, 20%, 30%**	**Coconuts yield loss [+] 10%, 20%, 30%**	**Decrease in price of bananas [-] 10%, 20%, 30%**	**Decrease in price of coconuts [-] 10%, 20%, 30%**	**Increase in price of piglets [+] 10%, 20%, 30%**		
	Positive incremental financial results persist after sensitization up to 30%	Positive incremental financial results persist after sensitization up to 30%	Positive incremental financial results persist after sensitization up to 30%	Positive incremental financial results persist after sensitization up to 30%	Positive incremental financial results persist after sensitization up to 30%		
CRA enterprise 6	**Robusta yield loss [+] 10%, 20%, 30%**	**Peanuts yield loss [+] 10%, 20%, 30%**	**Decrease in price of Robusta [-] 10%, 20%, 30%**	**Decrease in price of peanuts [-] 10%, 20%, 30%**			
	Positive incremental financial results persist after sensitization up to 30%	Positive incremental financial results persist after sensitization up to 30%	Positive incremental financial results persist after sensitization up to 30%	Positive incremental financial results persist after sensitization up to 30%			

CRA enterprise	Sensitized Variables per CRA enterprise						
CRA enterprise 7	**Coconuts yield loss [+] 10%, 20%, 30%**	**Cocoa yield loss [+] 10%, 20%, 30%**	**Decrease in price of coconuts [-] 10%, 20%, 30%**	**Decrease in price of cocoa [-] 10%, 20%, 30%**	**Increase in price of piglets [+] 10%, 20%, 30%**		
	Positive incremental financial results persist after sensitization up to 30%	Positive incremental financial results persist after sensitization up to 30%	Positive incremental financial results persist after sensitization up to 30%	Positive incremental financial results persist after sensitization up to 30%	Positive incremental financial results persist after sensitization up to 30%		
CRA enterprise 2B	**Rice yield loss [+] 10%, 20%, 30%**	**Onion yield loss [+] 10%, 20%, 30%**	**Decrease in price of rice [-] 10%, 20%, 30%**	**Decrease in price of onion [-] 10%, 20%, 30%**	**Increase in price of Urea [+] 10%, 20%, 30%**	**Increase in price of Complete [+] 10%, 20%, 30%**	**Increase in price of Potash [+] 10%, 20%, 30%**
	Positive incremental financial results persist after sensitization up to 30%	Positive incremental financial results persist after sensitization up to 30%	Positive incremental financial results persist after sensitization up to 30%	Positive incremental financial results persist after sensitization up to 20%. At 30% price decrease financial results turn into negative values.	Positive incremental financial results persist after sensitization up to 30%	Positive incremental financial results persist after sensitization up to 30%	Positive incremental financial results persist after sensitization up to 30%
CRA enterprise 3B	**Yellow corn yield loss [+] 10%, 20%, 30%**	**Peanuts yield loss [+] 10%, 20%, 30%**	**Decrease in price of yellow corn [-] 10%, 20%, 30%**	**Decrease in price of peanuts [-] 10%, 20%, 30%**	**Increase in price of Urea [+] 10%, 20%, 30%**	**Increase in price of Complete [+] 10%, 20%, 30%**	
	Positive incremental financial results persist after sensitization up to 30%	Positive incremental financial results persist after sensitization up to 30%	Positive incremental financial results persist after sensitization up to 30%	Positive incremental financial results persist after sensitization up to 10%. At 20% price decrease financial results turn into negative values.	Positive incremental financial results persist after sensitization up to 30%	Positive incremental financial results persist after sensitization up to 30%	

The results of financial part of sensitivity analysis show that the obtained ex-ante CBA results might be sensitive in some cases to changes in price of outputs and increase in yield losses. In the case of Intervention 2 and 2B, a 30% decrease in the price of onion turns financial incremental results into negative areas. In the case of intervention 3 and 3B a 20% decrease in price of peanuts turns financial incremental results into negative areas. In the case of Intervention 4, a 10% decrease in rice price turn financial incremental results into negative areas.

Table 10. Sensitivity Analysis Results (Incremental Economic Part/Incremental ENPVs).

CRA enterprise	Sensitized Variables per CRA enterprise						
CRA enterprise 1	**White potatoes yield loss [+] 10%, 20%, 30%**	**Green cabbage yield loss [+] 10%, 20%, 30%**	**Decrease in price of potatoes [-] 10%, 20%, 30%**	**Decrease in price of green cabbage [-] 10%, 20%, 30%**	**Increase in price of Urea [+] 10%, 20%, 30%**	**Increase in price of Complete [+] 10%, 20%, 30%**	**Increase in price of Potash [+] 10%20%, 30%**
	Positive incremental economic results persist after sensitization up to 30%	Positive incremental economic results persist after sensitization up to 30%	Positive incremental economic results persist after sensitization up to 30%	Positive incremental economic results persist after sensitization up to 30%	Positive incremental economic results persist after sensitization up to 30%	Positive incremental economic results persist after sensitization up to 30%	Positive incremental economic results persist after sensitization up to 30%
CRA enterprise 2	**Rice yield loss [+] 10%, 20%, 30%**	**Onion yield loss [+] 10%, 20%, 30%**	**Decrease in price of rice [-]10%, 20%, 30%**	**Decrease in price of onion [-] 10%, 20%, 30%**	**Increase in price of Urea [+] 10%, 20%, 30%**	**Increase in price of Complete [+] 10%, 20%, 30%**	**Increase in price of Potash [+] 10%, 20%, 30%**
	Positive incremental economic results persist after sensitization up to 30%	Positive incremental economic results persist after sensitization up to 30%	Positive incremental economic results persist after sensitization up to 30%	Positive incremental economic results persist after sensitization up to 10%. At 20% price decrease economic results turn into negative values.	Positive incremental economic results persist after sensitization up to 30%	Positive incremental economic results persist after sensitization up to 30%	Positive incremental economic results persist after sensitization up to 30%
CRA enterprise 3	**Yellow corn yield loss [+] 10%, 20%, 30%**	**Peanuts yield loss [+] 10%, 20%, 30%**	**Decrease in price of yellow corn [-] 10%, 20%, 30%**	**Decrease in price of peanuts [-] 10%, 20%, 30%**	**Increase in price of Urea [+] 10%, 20%, 30%**	**Increase in price of Complete [+] 10%, 20%, 30%**	
	Positive incremental economic results persist after sensitization up to 30%	Positive incremental economic results persist after sensitization up to 30%	Positive incremental economic results persist after sensitization up to 30%	Positive incremental economic results persist after sensitization up to 20%. At 30% price decrease economic results turn into negative values.	Positive incremental economic results persist after sensitization up to 30%	Positive incremental economic results persist after sensitization up to 30%	
CRA enterprise 4	**Rice price [-] 10%, 20%, 30%**						
	At 10 % price decrease economic results turn into negative values (in the case of lower carbon valuation) and						

CRA enterprise	Sensitized Variables per CRA enterprise						
	at 20% price increase (in the case of upper carbon valuation)						
CRA enterprise 5	**Bananas yield loss [+] 10%, 20%, 30%**	**Coconuts yield loss [+] 10%, 20%, 30%**	**Decrease in price of bananas [-] 10%, 20%, 30%**	**Decrease in price of coconuts [-] 10%, 20%, 30%**	**Increase in price of piglets[+] 10%, 20%, 30%**		
	Positive incremental economic results persist after sensitization up to 30%	Positive incremental economic results persist after sensitization up to 30%	Positive incremental economic results persist after sensitization up to 30%	Positive incremental economic results persist after sensitization up to 30%	Positive incremental economic results persist after sensitization up to 30%		
CRA enterprise 6	**Robusta yield loss [+] 10%, 20%, 30%**	**Peanuts yield loss [+] 10%, 20%, 30%**	**Decrease in price of Robusta [-] 10%, 20%, 30%**	**Decrease in price of peanuts [-] 10%, 20%, 30%**			
	Positive incremental economic results persist after sensitization up to 30%	Positive incremental economic results persist after sensitization up to 30%	Positive incremental economic results persist after sensitization up to 30%	Positive incremental economic results persist after sensitization up to 30%			
CRA enterprise 7	**Coconuts yield loss [+] 10%, 20%, 30%**	**Cocoa yield loss [+] 10%, 20%, 30%**	**Decrease in price of coconuts [-] 10%, 20%, 30%**	**Decrease in price of cocoa [-] 10%, 20%, 30%**	**Increase in price of piglets [+] 10%, 20%, 30%**		
	Positive incremental economic results persist after sensitization up to 30%	Positive incremental economic results persist after sensitization up to 30%	Positive incremental economic results persist after sensitization up to 30%	Positive incremental economic results persist after sensitization up to 30%	Positive incremental economic results persist after sensitization up to 30%		
CRA enterprise 2B	**Rice yield loss [+] 10%, 20%, 30%**	**Onion yield loss [+] 10%, 20%, 30%**	**Decrease in price of rice [-] 10%, 20%, 30%**	**Decrease in price of onion [-] 10%, 20%, 30%**	**Increase in price of Urea [+] 10%, 20%, 30%**	**Increase in price of Complete [+] 10%, 20%, 30%**	**Increase in price of Potash [+] 10%, 20%, 30%**
	Positive incremental economic results persist after sensitization up to 30%	Positive incremental economic results persist after sensitization up to 20%. At 30% price decrease economic results turn into negative values.	Positive incremental economic results persist after sensitization up to 30%	At 10 % price decrease economic results turn into negative values.	Positive incremental economic results persist after sensitization up to 30%	Positive incremental economic results persist after sensitization up to 30%	Positive incremental economic results persist after sensitization up to 30%

CRA enterprise	Sensitized Variables per CRA enterprise						
CRA enterprise 3B	**Yellow corn yield loss [+] 10%, 20%, 30%**	**Peanuts yield loss [+] 10%, 20%, 30%**	**Decrease in price of yellow corn [-] 10%, 20%, 30%**	**Decrease in price of peanuts [-] 10%, 20%, 30%**	**Increase in price of Urea [+] 10%, 20%, 30%**	**Increase in price of Complete [+] 10%, 20%, 30%**	
	Positive incremental economic results persist after sensitization up to 30%	Positive incremental economic results persist after sensitization up to 30%	Positive incremental economic results persist after sensitization up to 30%	Positive incremental economic results persist after sensitization up to 20%. At 30% price decrease economic results turn into negative values.	Positive incremental economic results persist after sensitization up to 30%	Positive incremental economic results persist after sensitization up to 30%	

The results of economic part of sensitivity analysis show that the obtained ex-ante CBA results might be sensitive in some cases to changes in price of outputs and increase in yield losses. In the case of Intervention 2 and 2B, a 20% and 10% decrease in the price of onion, respectively turns economic incremental results into negative areas. Also, in the case of intervention 2B a 30% increase in onion yield loss turns economic incremental results into negative areas. In the case of intervention 3 and 3B a 30% decrease in price of peanuts turns economic incremental results into negative areas. In the case of Intervention 4 (with lower carbon valuation), a 10% decrease in rice price turns economic incremental results into negative areas and a 20% increase in the price of rice, in the case of upper carbon valuation turns results into negative ones.

On the other hand, the sensitivity analysis results (financial and economic) show that Interventions 1, 5, 6, and 7 are insensitive to [+/-] 10%, 20%, 30% changes in selected variables.

The sensitivity to changes in outputs' prices and yield loss is typical to agriculture and is not specific to the CRA enterprises-types assessed in this analysis. The issues associated with the changing pricing of outputs and periodic increase in yield loss are usually addressed through proper and timely monitoring and advisory services at implementation.

5.3. Project's Overall Benefits versus Costs

Project's overall incremental economic net benefits were also juxtaposed against project's budgeted costs. The results are outlined in Table 11 below. A sensitivity analysis was pursued on these results assuming 10%-50% decrease in net economic incremental benefits. The results of this analysis are outlined in Table 12 below.

Table 11. Project's Overall Incremental Economic Benefits.

Project's Overall Incremental Economic Results (with lower carbon pricing)			
	PHP ('000)		**USD ('000)**
ENPV	27,601,927		530,806
EIRR		35%	
EMIRR		16%	
Project's Overall Incremental Economic Results (with upper carbon pricing)			
	PHP ('000)		**USD ('000)**
ENPV	30,462,174		585,811
EIRR		37%	
EMIRR		17%	

Table 12. Project's Overall Economic Results-Sensitivity Results.

Sensitivity Results				
Project's Overall Incremental Economic Results (with lower carbon pricing)				
	PHP ('000) ENPV	**USD ('000) ENPV**	**EIRR**	**EMIRR**
Benefits [-10%]	24,718,938	475,364	34%	16%
Benefits [-20%]	21,753,211	418,331	32%	16%
Benefits [-30%]	18,787,483	361,298	31%	16%
Benefits [-40%]	15,821,756	304,265	30%	16%
Benefits [-50%]	12,856,028	247,231	28%	15%
Project's Overall Incremental Economic Results (with upper carbon pricing)				
	PHP ('000) ENPV	**USD ('000) ENPV**	**EIRR**	**EMIRR**
Benefits [-10%]	27,218,696	523,436	36%	17%
Benefits [-20%]	23,975,218	461,062	34%	17%
Benefits [-30%]	20,731,739	398,687	33%	16%
Benefits [-40%]	17,488,261	336,313	31%	16%
Benefits [-50%]	14,244,783	273,938	29%	16%

5.4. Sensitivity Analysis on Adoption Rates of CRAs

Additional analysis was pursued to verify how the incremental FNPVs and ENPVs could change, assuming different numbers of CRA adopters. The results of this analysis are presented on the "per CRA-type" -basis in Table 13 below. Please note that the ENPVs additionally show differences in ENPVs using different valuations of carbon co-benefits: lower versus upper carbon valuation. Also, CRA6 does not demonstrate any carbon co-benefits that could be estimated using the EX-Act software. Therefore, in the case of CRA6, the ENPV results obtained using lower carbon pricing are equal to those obtained using upper bound carbon pricing.

5.5. Additional Potential Benefits -Qualitative Assessment

While the results of the quantitative analysis outlined in Sections 5.1-5.3 above show a convincing picture for the rationale of implementing proposed interventions, there exists some other potential unquantifiable benefits that are not possible to measure upfront. These extra benefits are expected to accrue to an estimated 5 million of farmers-beneficiaries that would benefit from the spillover effect of interventions that would benefit the estimated 1.25 million of direct beneficiaries.

These indirect farmers-beneficiaries are expected to adjust their current farming practices and adopt some of the CRA practices, as modeled in seven CRA enterprises-types. Consequently, these farmers-beneficiaries are envisioned to obtain some potential incomes gains from knowledge spillover, peer learning, access to information about the CRA practices organized via awareness campaigns and information dissemination. However, these gains that could potentially be significant cannot be estimated precisely upfront.

Table 13. Incremental FNPV/ENPVs for Assumed Adoption Rates (per CRA enterprise type and assuming lower versus upper carbon pricing, respectively).

Aggregate Incremental FNPV/ENPV Results. Lower carbon pricing assumed for the ENPVs.		**Assumed # of CRA 1**	**Aggregate Incremental FNPV/ENPV Results. Upper carbon pricing assumed for the ENPVs.**		**Assumed # of CRA 1**
Values in '000 USD			**Values in '000 USD**		
FNPV	473,016	30,000	FNPV	473,016	30,000
FNPV	394,180	25,000	FNPV	394,180	25,000
FNPV	315,344	20,000	FNPV	315,344	20,000
FNPV	236,508	15,000	FNPV	236,508	15,000
FNPV	157,672	10,000	FNPV	157,672	10,000
Values in '000 USD			**Values in '000 USD**		
ENPV	360,186	30,000	ENPV	360,328	30,000
ENPV	300,155	25,000	ENPV	300,274	25,000
ENPV	240,124	20,000	ENPV	240,219	20,000
ENPV	180,093	15,000	ENPV	180,164	15,000
ENPV	120,062	10,000	ENPV	120,109	10,000
Aggregate Incremental FNPV/ENPV Results. Lower carbon pricing assumed for the ENPVs.		**Assumed # of CRA 2**	**Aggregate Incremental FNPV/ENPV Results. Upper carbon pricing assumed for the ENPVs.**		**Assumed # of CRA 2**
Values in '000 USD			**Values in '000 USD**		
FNPV	321,651	35,000	FNPV	321,651	35,000
FNPV	275,701	30,000	FNPV	275,701	30,000
FNPV	229,750	25,000	FNPV	229,750	25,000
FNPV	183,800	20,000	FNPV	183,800	20,000
FNPV	137,850	15,000	FNPV	137,850	15,000
FNPV	91,900	10,000	FNPV	91,900	10,000
Values in '000 USD			**Values in '000 USD**		
ENPV	126,742	35,000	ENPV	137,394	35,000
ENPV	108,636	30,000	ENPV	117,766	30,000
ENPV	90,530	25,000	ENPV	98,139	25,000
ENPV	72,424	20,000	ENPV	78,511	20,000
ENPV	54,318	15,000	ENPV	58,883	15,000
ENPV	36,212	10,000	ENPV	39,255	10,000

Aggregate Incremental FNPV/ENPV Results. Lower carbon pricing assumed for the ENPVs.		**Assumed # of CRA 3**	**Aggregate Incremental FNPV/ENPV Results. Upper carbon pricing assumed for the ENPVs.**		**Assumed # of CRA 3**
Values in '000 USD			**Values in '000 USD**		
FNPV	49,471	32,500	FNPV	49,471	32,500
FNPV	45,666	30,000	FNPV	45,666	30,000
FNPV	38,055	25,000	FNPV	38,055	25,000
FNPV	30,444	20,000	FNPV	30,444	20,000
FNPV	22,833	15,000	FNPV	22,833	15,000
FNPV	15,222	10,000	FNPV	15,222	10,000
Values in '000 USD			**Values in '000 USD**		
ENPV	76,006	32,500	ENPV	87,289	32,500
ENPV	70,160	30,000	ENPV	80,575	30,000
ENPV	58,466	25,000	ENPV	67,145	25,000
ENPV	46,773	20,000	ENPV	53,716	20,000
ENPV	35,080	15,000	ENPV	40,287	15,000
ENPV	23,387	10,000	ENPV	26,858	10,000
Aggregate Incremental FNPV/ENPV Results. Lower carbon pricing assumed for the ENPVs.		**Assumed # of CRA 4**	**Aggregate Incremental FNPV/ENPV Results. Upper carbon pricing assumed for the ENPVs.**		**Assumed # of CRA 4**
Values in '000 USD			**Values in '000 USD**		
FNPV	77,970	32,500	FNPV	77,970	32,500
FNPV	71,972	30,000	FNPV	71,972	30,000
FNPV	59,977	25,000	FNPV	59,977	25,000
FNPV	47,982	20,000	FNPV	47,982	20,000
FNPV	35,986	15,000	FNPV	35,986	15,000
FNPV	23,991	10,000	FNPV	23,991	10,000
Values in '000 USD			**Values in '000 USD**		
ENPV	62,285	32,500	ENPV	129,053	32,500
ENPV	57,494	30,000	ENPV	119,126	30,000
ENPV	47,912	25,000	ENPV	99,272	25,000
ENPV	38,329	20,000	ENPV	79,418	20,000
ENPV	28,747	15,000	ENPV	59,563	15,000
ENPV	19,165	10,000	ENPV	39,709	10,000

Aggregate Incremental FNPV/ENPV Results. Lower carbon pricing assumed for the ENPVs.		**Assumed # of CRA 5**	**Aggregate Incremental FNPV/ENPV Results. Upper carbon pricing assumed for the ENPVs.**		**Assumed # of CRA 5**
Values in '000 USD			**Values in '000 USD**		
FNPV	70,903	50,000	FNPV	70,903	50,000
FNPV	63,812	45,000	FNPV	63,812	45,000
FNPV	56,722	40,000	FNPV	56,722	40,000
FNPV	49,632	35,000	FNPV	49,632	35,000
FNPV	42,542	30,000	FNPV	42,542	30,000
FNPV	35,451	25,000	FNPV	35,451	25,000
FNPV	28,361	20,000	FNPV	28,361	20,000
FNPV	21,271	15,000	FNPV	21,271	15,000
FNPV	14,181	10,000	FNPV	14,181	10,000
Values in '000 USD			**Values in '000 USD**		
ENPV	114,606	50,000	ENPV	126,020	50,000
ENPV	103,146	45,000	ENPV	113,418	45,000
ENPV	91,685	40,000	ENPV	100,816	40,000
ENPV	80,224	35,000	ENPV	88,214	35,000
ENPV	68,764	30,000	ENPV	75,612	30,000
ENPV	57,303	25,000	ENPV	63,010	25,000
ENPV	45,842	20,000	ENPV	50,408	20,000
ENPV	34,382	15,000	ENPV	37,806	15,000
ENPV	22,921	10,000	ENPV	25,204	10,000

Aggregate Incremental FNPV/ENPV Results. Lower carbon pricing assumed for the ENPVs.		**Assumed # of CRA 6**	**Aggregate Incremental FNPV/ENPV Results. Upper carbon pricing assumed for the ENPVs.**		**Assumed # of CRA 6**
Values in '000 USD			**Values in '000 USD**		
FNPV	92,008	35,000	FNPV	92,008	35,000
FNPV	78,864	30,000	FNPV	78,864	30,000
FNPV	65,720	25,000	FNPV	65,720	25,000
FNPV	52,576	20,000	FNPV	52,576	20,000
FNPV	39,432	15,000	FNPV	39,432	15,000
FNPV	26,288	10,000	FNPV	26,288	10,000
Values in '000 USD			**Values in '000 USD**		
ENPV	97,659	35,000	ENPV	97,659	35,000
ENPV	83,708	30,000	ENPV	83,708	30,000
ENPV	69,756	25,000	ENPV	69,756	25,000
ENPV	55,805	20,000	ENPV	55,805	20,000
ENPV	41,854	15,000	ENPV	41,854	15,000
ENPV	27,903	10,000	ENPV	27,903	10,000
Aggregate Incremental FNPV/ENPV Results. Lower carbon pricing assumed for the ENPVs.		**Assumed # of CRA 7**	**Aggregate Incremental FNPV/ENPV Results. Upper carbon pricing assumed for the ENPVs.**		**Assumed # of CRA 7**
Values in '000 USD			**Values in '000 USD**		
FNPV	196,941	35,000	FNPV	196,941	35,000
FNPV	168,807	30,000	FNPV	168,807	30,000
FNPV	140,672	25,000	FNPV	140,672	25,000
FNPV	112,538	20,000	FNPV	112,538	20,000
FNPV	84,403	15,000	FNPV	84,403	15,000
FNPV	56,269	10,000	FNPV	56,269	10,000
Values in '000 USD			**Values in '000 USD**		
ENPV	283,118	35,000	ENPV	286,947	35,000
ENPV	242,673	30,000	ENPV	245,954	30,000
ENPV	202,227	25,000	ENPV	204,962	25,000
ENPV	161,782	20,000	ENPV	163,969	20,000
ENPV	121,336	15,000	ENPV	122,977	15,000
ENPV	80,891	10,000	ENPV	81,985	10,000

Aggregate Incremental FNPV/ENPV Results. Lower carbon pricing assumed for the ENPVs.		**Assumed # of CRA 2B**	**Aggregate Incremental FNPV/ENPV Results. Upper carbon pricing assumed for the ENPVs.**		**Assumed # of CRA 2B**
Values in '000 USD			**Values in '000 USD**		
FNPV	265,736	35,000	FNPV	265,736	35,000
FNPV	227,774	30,000	FNPV	227,774	30,000
FNPV	189,811	25,000	FNPV	189,811	25,000
FNPV	151,849	20,000	FNPV	151,849	20,000
FNPV	113,887	15,000	FNPV	113,887	15,000
FNPV	75,925	10,000	FNPV	75,925	10,000
Values in '000 USD			**Values in '000 USD**		
EPV	70,837	35,000	EPV	81,490	35,000
ENPV	60,717	30,000	ENPV	69,848	30,000
ENPV	50,598	25,000	ENPV	58,207	25,000
ENPV	40,478	20,000	ENPV	46,565	20,000
ENPV	30,359	15,000	ENPV	34,924	15,000
ENPV	20,239	10,000	ENPV	23,283	10,000
Aggregate Incremental FNPV/ENPV Results. Lower carbon pricing assumed for the ENPVs.		**Assumed # of CRA 3B**	**Aggregate Incremental FNPV/ENPV Results. Upper carbon pricing assumed for the ENPVs.**		**Assumed # of CRA 3B**
Values in '000 USD			**Values in '000 USD**		
FNPV	52,085	32,500	FNPV	52,085	32,500
FNPV	48,079	30,000	FNPV	48,079	30,000
FNPV	40,066	25,000	FNPV	40,066	25,000
FNPV	32,053	20,000	FNPV	32,053	20,000
FNPV	24,039	15,000	FNPV	24,039	15,000
FNPV	16,026	10,000	FNPV	16,026	10,000
Values in '000 USD			**Values in '000 USD**		
ENPV	75,839	32,500	ENPV	87,122	32,500
ENPV	73,011	30,000	ENPV	80,420	30,000
ENPV	58,338	25,000	ENPV	67,017	25,000
ENPV	46,670	20,000	ENPV	53,613	20,000
ENPV	35,003	15,000	ENPV	40,210	15,000
ENPV	23,335	10,000	ENPV	26,807	10,000

6. Analytical Limitations

Several elements might interfere with the CBA results, but they are beyond the scope of this analysis. The first potential problem is associated with the choice of scenarios for the analysis. The scenarios were constructed based on feasibility study and data from previous interviews with Filipino farmers in various areas of the country. This knowledge was supplemented by desktop review. Specific care was taken to make sure that proposed scenarios are as realistic as possible; however, there still might exist some unknown specifics in farming styles in different zones of interest of this proposal that are unknown to the analyst that prepared this work. The specifics of this type of analysis (ex-ante CBA) by nature include some levels of uncertainty that will be verified and adjusted once the interventions are implemented.

Also, the COVID-19 pandemic, its effects on the global economy, and the Philippine economy are all equally hard to predict. At the time of this analysis, it is still somewhat unclear how the global and Philippine economies will cope with the expected economic downturn associated with the pandemic. As the pandemic is ongoing, it is close to impossible to provide any well-supported prognosis. Even so, it is already established that the pandemic is expected to have a significant impact on several macroeconomic variables (for example, inflation and interest rates). There is also a risk that similar pandemics will occur in the future, possibly with greater frequency.

None of these prospects mentioned in this section have been included or assessed in the ex-ante CBA for the proposed grant funding due to a lack of reliable information on these topics and embedded high levels of uncertainty.

7. Conclusions

The ex-ante CBA results for this grant proposal suggest that all proposed and assessed interventions are likely to be beneficial to Filipino small-scale farmers that will be included in this project. The proposed interventions are also likely to benefit the entire Philippine economy.

In CRA enterprises 1, 5, 6, and 7, the sensitivity analysis shows robust incremental economic benefits suggesting lower possible risk once these interventions are implemented. Some caveats exist in the case of CRA enterprises 2, 3 (as well as 2B and 3B) and 4. Therefore, in the case of the latter interventions it is advised to keep close monitoring of pricing of the modeled commodities (organic rice, onion, and peanuts) to ensure that incremental benefits will accrue to farmers and the risk associated with the fluctuation of prices of these commodities will be internalized and

acted upon. Alternatively, during implementation and monitoring it might be necessary to suggest to farmers some additional farm income mitigation options like the inclusion of animals for fattening that will help manage risk associated with fluctuating prices of commodities of interest. Also, gaining some additional skills regarding marketing and price negotiating might be beneficial for farmers engaged in the CRA enterprises. These additional elements might help farmers-beneficiaries better mitigate potential additional risks.

Regarding the Carbon co-benefits. Six out of seven proposed interventions show Carbon co-benefits and are likely to influence the environment at large positively. While Intervention 6 (Robusta coffee intercropping with peanuts) doesn't show Carbon co-benefits, it doesn't mean that there won't be any. It means that the software EX-ACT in its current version is just not able to capture any Carbon co-benefits.[28]

[28] This is due to the current shortcomings of the EX-ACT software.

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Annex 1

Table 14. Overall Aggregate Financial and Economic Results for all proposed CRAs.

Aggregate results CRA 1-7 (overall)			
Financial in '000 PHP	**WOP**	**WP**	**Incremental**
FNPV	37,271,846	103,484,216	66,212,369
Financial in '000 USD or %			
FNPV	716,766	1,990,081	1,273,315
Financial Internal Rate of Return in %			
FIRR (%)	52%	63%	73%
Modified Financial Internal Rate of Return in %			
MIRR (%)	18%	20%	21%
Economic Lower Carbon Pricing in '000 PHP	**WOP**	**WP**	**Incremental**
ENPV	11,684,099	69,477,736	57,793,637
Economic Lower Carbon Pricing in '000 USD			
ENPV	224,694	1,336,110	1,111,416
Economic Interna Rate of Return in %			
EIRR (%)	23%	42%	60%
Modified Economic Interna Rate of Return in %			
EMIRR (%)	14%	18%	21%
Economic UPPER Carbon Pricing in '000 PHP	**WOP**	**WP**	**Incremental**
ENPV	11,684,099	74,890,315	63,206,216
Economic UPPER Carbon Pricing in '000 USD			
ENPV	224,694	1,440,198	1,215,504
Economic Interna Rate of Return in %			
EIRR (%)	23%	45%	67%
Modified Economic Interna Rate of Return in %			
EMIRR (%)	14%	18%	21%

Annex 2.

EX-ACT follows a Tier 1 approach (using IPCC default emission factors and land-use & conversion factors) and can be refined, when locally specific information on emission factors are available (Tier 2). In this case, most of the interventions are based on the Tier 1 approach. Interventions 5 and 7 use Tier 2 values from Raveendra et al. 2017 to account for the increased carbon-sequestration of the agroforestry systems as compared to the monocropping culture.

The different interventions have slightly different effects on GHG. For example, Intervention 2 decreases methane emissions, and Intervention 5 increases overall carbon-sequestration. Sloping Agricultural Land Technology (SALT) will stabilize the soils, and hence affect soil C sequestrations, although here assumed SALT will only affect annual croplands through the improved C-seq in the soils. There may be further benefits if integrated SALT systems get established with more intercropped perennial crops and trees. For further information, see the Interventions assumptions below.

Table 15. EX-ACT Results.

Intervention	Carbon-balance per 1 ha/per year/per intervention	Assumed # of ha per intervention	Total emission reductions per year per intervention type (aggregate)	Total emissions savings per intervention type over 20 years
Intervention 1	-0,01 tCO2e.	30,000	-300 tCO2e	-6,000tCO2e
Intervention 2	-0,64 tCO2e.	35,000	-22,400tCO2e	-448,000tCO2e
Intervention 3	-0,73 tCO2e.	32,500	-23,725 tCO2e	-474,500tCO2e
Intervention 4	-4,32 tCO2e.	32,500	-140,400tCO2e	-2,808,000tCO2
Intervention 5	-0,48 tCO2e.	50,000	-24,000tCO2e	-480,000tCO2e
Intervention 6	0,00 tCO2e.	35,000	0	0
Intervention 7	-0,23 tCO2e.	35,000	-8,050tCO2e	-161,000tCO2e
Total 1-7		**250,000**	**-218,875 tCO2e**	**-4,377,500 tCO2e**

Table 16. GHG /EX-ACT-Related Assumptions, per Intervention.

Intervention and region	Description	GHG related effects for Ex-Act assumptions
Intervention 1 (models based on CAR specifics)	Introduction of blight resistant white potatoes-green cabbage crops rotation and construction of rainwater harvesting tank for irrigation purposes.	As manure is already applied without the project, there is no further carbon-sequestrations in the soil in the WP situation (based on IPCC 2006). Yet, the project decreases the use of Potassium, which decreases CO2 emissions from production, transportation, storage and transfer (and offsets the additional emissions of the construction of water harvesting tank).
Intervention 2 (models based on CAR specifics)	Introduction of rice-onion crops rotation with early maturing rice cultivars.	The project will introduce early maturing rice cultivars, which will reduce the cultivation period from 180 days (6 months in conventional systems in the Philippines (FAO, 2004)) to 150 days (or 5 months). With a daily emission factor held constant (i.e. assuming that the EF(basis), SF(before), SF(during) and SF(org. amendment)) in both the WOP and WP situation, a reduction in the cultivation period will reduce the overall methane emissions (IPCC 2006, Vol. 4, Chapter 5, Equation 5.2).
Intervention 3 (models based on Cagayan Valley specifics)	Introduction of yellow corn-peanuts (groundnuts) rotation with drought resistant yellow corn cultivars. Additional introduction of Sloping Agricultural Land Technology (SALT).	The project will introduce a corn-peanut crop rotation with SALT technology. Considering that SALT aims at improving the soil health, this intervention was classified as improved agronomic practices (as there will be an increase in soil carbon from this intervention). The rate of soil carbon sequestration is 0.24 tC/ha/yr (Smith et al., 2005) and the intervention will hence sequester carbon in the soils.
Intervention 4 (models based on Cagayan Valley specifics)	Introduction of organic rice cultivation (2 rotations per year) with alternate wetting and drying irrigation-System of Rice Intensification (SRI).	The project will introduce SWIS and alternate wetting and drying. While assumed that this won't change the cultivation period (to be conservative), the water regimes before and during the cultivation period and organic amendments are expected to change. The water regime during the cultivation period will change from irrigated (continuously flooded) to Irrigated - Intermittently flooded with multiple aerations. Water management before the cultivation will also be improved: from Flooded pre-season (>30 days) to a non-Flooded preseason (<180 days). Straws are conventionally exported but they will be incorporated long before cultivation (>30 days). This intervention will hence lead to an overall reduction of methane emissions.
Intervention 5 (models based on Bicol specifics)	Coconuts-bananas intercropping	The project will shift from a coconut monocropping system to an alley cropping agroforestry system, where coconuts and bananas are intercropped. For the coconut monocropping system, a Tier 2 value was retrieved from Raveendra et al. 2017, where coconut monocultures had a total C content of 60.01 for a 30y plantation (due to lack of further information, on the C-compartments, used this value as a Tier 2-value in the AGB-growth rate, while holding the growth rates for BGB and Soils at 0). Through the conversion to an alley cropping system, the intervention will hence increase the overall carbon-sequestration by the perennial system.
Intervention 6 (models based on Bukidnon specifics)	Intercropping of coffee with peanuts (groundnuts) and Sloping Agricultural Land Technology (SALT) for Robusta coffee production	As this intervention will solely introduce annual crops that are to be intercropped with the existing coffee plantations, this will have no (or very little impact that cannot be quantified with EX-ACT) on C-sequestration rates. Thus carbon-balance of this intervention will be 0.
Intervention 7 (models based on SOCCSKARGEN specifics)	Introduction of cocoa - coconuts intercropping (organic production)	Intervention 7 follows the same logic as Intervention 5. Through the conversion to an alley cropping system, the intervention will hence increase the overall carbon-sequestration by the perennial system.