

Annex 16 Mitigation GHG calculation

GHG emission reductions/gains and resulting carbon balance from proposed CRA intervention packages are assessed using FAO's Ex-Ante Carbon-balance Tool (EX-ACT) for a 20-year period with a project implementation period of 7 years and 13 years of capitalization. The EX-ACT is an appraisal tool providing ex-ante estimates of the impact of agriculture and forestry development projects, programs, and policies on the carbon-balance, based primarily on recognized default values for emission factors and carbon values - the Tier 1 level of precision – from the Intergovernmental Panel on Climate Change 2006 Guidelines for National Greenhouse Gas Inventories (IPCC, 2006).

There are 7 main intervention packages that will be geared towards project's direct beneficiaries (Table 1). These interventions are proposed to be introduced in pre-selected regions (Table 2).

For each of the intervention packages, carbon balance is computed per assumed number of hectares where the interventions will be put in place, and the total carbon balance over 20 years is computed based on the area estimate of 1 ha per farmer household in each region and aggregated up to assumed total number of hectares (Table 2). This amounts to total reduction of GHG emissions by 4,377,500 tCO₂e (4.38 million tCO₂eq) over 20 years in all areas combined. The annual reduction in GHG emissions in all areas combined is 218,875 tCO₂e¹.

The assumptions used for setting up EX-ACT scenarios are presented in Table 1 below. These assumptions and carbon volumes were used and included in the economic part of the Economic and Financial analysis for carbon valuations.

The detailed results of EX-ACT calculations are summarized in Tables 3 to 9.

Table 1. CRA intervention packages and their benefits in terms of adaptation and mitigation

CRA intervention package	GHG related effects for EX-ACT assumptions
1. 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 CO ₂ emissions from production, transportation, storage and transfer (and offsets the additional emissions of the construction of water harvesting tank).
2. 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).
3. 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.
4. 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 pre-season (<180 days). Straws are conventionally

¹ Note: EX-ACT results per ha presented in Table 2 below were rounded for simplicity of calculations.

	exported but they will be incorporated long before cultivation (>30 days). This intervention will hence lead to an overall reduction of methane emissions.
5. 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.
6. 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.
7. 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.

Table 2. CRA intervention packages, and their carbon balance, based on farmland size in which each intervention will be introduced

Intervention	Carbon balance per 1 ha/per year/per intervention (tCO₂eq)	Assumed # of farmland per intervention (ha)	Total emission reductions per year per intervention type (tCO₂eq)	Total emission reductions per intervention type over 20 years (tCO₂eq)
Intervention 1	-0.01	30,000	-300	-6,000
Intervention 2	-0.64	35,000	-22,400	-448,000
Intervention 3	-0.73	32,500	-23,725	-474,500
Intervention 4	-4.32	32,500	-140,400	-2,808,000
Intervention 5	-0.48	50,000	-24,000	-480,000
Intervention 6	0.00	35,000	0	0
Intervention 7	-0.23	35,000	-8,050	-161,000
Total 1-7		250,000	-218,875	-4,377,500

Table 3. EX-ACT summary for Intervention 1

Project Name	Philippines	Climate	Tropical (Wet)	Duration of the Project (Years)	20					
Continent	Asia (Insular)	Dominant Regional Soil Type	HAC Soils	Total area (ha)	50000					
Components of the project	Gross fluxes		Share per GHG of the Balance					Result per year		
	Without	With	Balance	All GHG in tCO2eq			Without	With	Balance	
Land use changes	All GHG in tCO2eq			CO2	N2O	CH4				
	Positive = source / negative = sink			Biomass	Soil	Other				
Deforestation	0	0	0	0	0	0	0	0	0	
Afforestation	0	0	0	0	0	0	0	0	0	
Other LUC	0	0	0	0	0	0	0	0	0	
Agriculture										
Annual	-2,790,000	-2,790,000	0	0	0	0	-139,500	-139,500	0	
Perennial	0	0	0	0	0	0	0	0	0	
Rice	0	0	0	0	0	0	0	0	0	
Grassland & Livestocks										
Grassland	0	0	0	0	0	0	0	0	0	
Livestocks	0	0	0		0	0	0	0	0	
Degradation & Management										
Forest degradation	0	0	0	0	0	0	0	0	0	
Peat extraction	0	0	0		0	0	0	0	0	
Drainage organic soil	0	0	0		0	0	0	0	0	
Rewetting organic soil	0	0	0		0	0	0	0	0	
Fire organic soil	0	0	0	0	0	0	0	0	0	
Coastal wetlands	0	0	0	0	0	0	0	0	0	
Inputs & Investments	423,390	409,843	-13,547			-13,547	0	0	-677	
Fishery & Aquaculture	0	0	0			0	0	0	0	
Total	-2,366,610	-2,380,157	-13,547	0	0	-13,547	0	0	-118,331	
Per hectare	-47.3	-47.6	-0.3	-0.3	0.0	-0.3	0.0	0.0	-119,008	
Per hectare per year	-2.4	-2.4	0.0	0.0	0.0	0.0	0.0	0.0	-677	

Table 4. EX-ACT summary for Intervention 2

Project Name	Philippines	Climate	Tropical (Wet)	Duration of the Project (Years)		20				
Continent	Asia (Insular)	Dominant Regional Soil Type	HAC Soils	Total area (ha)		0				
Components of the project	Gross fluxes			Share per GHG of the Balance		Result per year				
	Without	With	Balance	All GHG in tCO2eq		Without	With	Balance		
Land use changes	All GHG in tCO2eq			CO2		N2O	CH4			
	Positive = source / negative = sink			Biomass	Soil	Other				
Deforestation	0	0	0	0	0	0	0	0		
Afforestation	0	0	0	0	0	0	0	0		
Other LUC	0	0	0	0	0	0	0	0		
Agriculture	Annual	0	0	0	0	0	0	0		
	Perennial	0	0	0	0	0	0	0		
	Rice	4,686,084	4,041,747	-644,337	0	0	0	-644,337	234,304	202,087
Grassland & Livestocks	Grassland	0	0	0	0	0	0	0		
	Livestocks	0	0	0		0	0	0		
Degradation & Management	Forest degradation	0	0	0	0	0	0	0		
	Peat extraction	0	0	0		0	0	0		
	Drainage organic soil	0	0	0		0	0	0		
	Rewetting organic soil	0	0	0		0	0	0		
	Fire organic soil	0	0	0	0		0	0		
	Coastal wetlands	0	0	0	0	0	0	0		
Inputs & Investments	0	0	0			0	0	0		
Fishery & Aquaculture	0	0	0			0	0	0		
Total	4,686,084	4,041,747	-644,337	0	0	0	-644,337	234,304	202,087	-32,217
Per hectare	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Per hectare per year	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 5. EX-ACT summary for Intervention 3

Project Name	Philippines	Climate	Tropical (Wet)	Duration of the Project (Years)	20						
Continent	Asia (Insular)	Dominant Regional Soil Type	HAC Soils	Total area (ha)	50000						
Components of the project	Gross fluxes			Share per GHG of the Balance					Result per year		
	Without	With	Balance	All GHG in tCO2eq					Without	With	Balance
Land use changes	All GHG in tCO2eq			CO2					N2O	CH4	
	Positive = source / negative = sink			Biomass	Soil	Other					
Deforestation	0	0	0	0	0		0	0	0	0	0
Afforestation	0	0	0	0	0		0	0	0	0	0
Other LUC	0	0	0	0	0		0	0	0	0	0
Agriculture											
Annual	65,155	-667,327	-732,483	0	-814,000		81,517	0	3,258	-33,366	-36,624
Perennial	0	0	0	0	0		0	0	0	0	0
Rice	0	0	0	0	0		0	0	0	0	0
Grassland & Livestocks											
Grassland	0	0	0	0	0		0	0	0	0	0
Livestocks	0	0	0				0	0	0	0	0
Degradation & Management											
Forest degradation	0	0	0	0	0		0	0	0	0	0
Peat extraction	0	0	0		0		0	0	0	0	0
Drainage organic soil	0	0	0		0		0	0	0	0	0
Rewetting organic soil	0	0	0		0		0	0	0	0	0
Fire organic soil	0	0	0	0	0			0	0	0	0
Coastal wetlands	0	0	0	0	0		0	0	0	0	0
Inputs & Investments	0	0	0			0	0	0	0	0	0
Fishery & Aquaculture	0	0	0			0	0	0	0	0	0
Total	65,155	-667,327	-732,483	0	-814,000	0	81,517	0	3,258	-33,366	-36,624
Per hectare	1.3	-13.3	-14.6	0.0	-16.3	0.0	1.6	0.0			
Per hectare per year	0.1	-0.7	-0.7	0.0	-0.8	0.0	0.1	0.0	0.1	-0.7	-0.7

Table 6. EX-ACT summary for Intervention 4

[illegible]

Table 7. EX-ACT summary for Intervention 5

Project Name	Philippines	Climate	Tropical (Wet)	Duration of the Project (Years)	20						
Continent	Asia (Insular)	Dominant Regional Soil Type	HAC Soils	Total area (ha)	50000						
Components of the project	Gross fluxes		Share per GHG of the Balance			Result per year					
	Without	With	Balance	All GHG in tCO2eq		Without	With	Balance			
Land use changes	All GHG in tCO2eq			CO2	N2O	CH4					
	Positive = source / negative = sink			Biomass	Soil	Other					
	Deforestation	0	0	0	0	0	0	0			
	Afforestation	0	0	0	0	0	0	0			
Agriculture	Other LUC	0	0	0	0	0	0	0			
	Annual	0	0	0	0	0	0	0			
	Perennial	-2,000,000	-2,478,500	-478,500	99,000	-577,500	0	0	-100,000		
Grassland & Livestocks	Rice	0	0	0	0	0	0	0			
	Grassland	0	0	0	0	0	0	0			
Degradation & Management	Livestocks	12,474,306	12,474,306	0	0	0	0	623,715			
	Forest degradation	0	0	0	0	0	0	0			
	Peat extraction	0	0	0	0	0	0	0			
	Drainage organic soil	0	0	0	0	0	0	0			
Coastal wetlands	Rewetting organic soil	0	0	0	0	0	0	0			
	Fire organic soil	0	0	0	0	0	0	0			
	Fire organic soil	0	0	0	0	0	0	0			
Inputs & Investments	0	0	0	0	0	0	0	0			
Fishery & Aquaculture	0	0	0	0	0	0	0	0			
Total	10,474,306	9,995,806	-478,500	99,000	-577,500	0	0	0	523,715	499,790	-23,925
Per hectare	209.5	199.9	-9.6	2.0	-11.6	0.0	0.0	0.0			
Per hectare per year	10.5	10.0	-0.5	0.1	-0.6	0.0	0.0	0.0	10.5	10.0	-0.5

Table 8. EX-ACT summary for Intervention 6

Project Name		Philippines	Climate	Tropical (Wet)		Duration of the Project (Years)		20				
Continent		Asia (Insular)	Dominant Regional Soil Type	HAC Soils		Total area (ha)		50000				
Components of the project	Gross fluxes			Share per GHG of the Balance				Result per year				
	Without	With	Balance	All GHG in tCO2eq			N ₂ O	CH ₄	Without	With	Balance	
	All GHG in tCO2eq			CO ₂								
Land use changes	Positive = source / negative = sink			Biomass	Soil	Other						
Deforestation	0	0	0	0	0		0	0	0	0	0	0
Afforestation	0	0	0	0	0		0	0	0	0	0	0
Other LUC	0	0	0	0	0		0	0	0	0	0	0
Agriculture												
Annual	0	0	0	0	0		0	0	0	0	0	0
Perennial	-2,869,996	-2,869,996	0	0	0		0	0	-143,500	-143,500	0	0
Rice	0	0	0	0	0		0	0	0	0	0	0
Grassland & Livestocks												
Grassland	0	0	0	0	0		0	0	0	0	0	0
Livestocks	0	0	0				0	0	0	0	0	0
Degradation & Management												
Forest degradation	0	0	0	0	0		0	0	0	0	0	0
Peat extraction	0	0	0		0		0	0	0	0	0	0
Drainage organic soil	0	0	0		0		0	0	0	0	0	0
Rewetting organic soil	0	0	0		0		0	0	0	0	0	0
Fire organic soil	0	0	0		0		0	0	0	0	0	0
Coastal wetlands	0	0	0	0	0		0	0	0	0	0	0
Inputs & Investments	0	0	0			0	0	0	0	0	0	0
Fishery & Aquaculture	0	0	0			0	0	0	0	0	0	0
Total	-2,869,996	-2,869,996	0	0	0	0	0	0	-143,500	-143,500	0	0
Per hectare	-57.4	-57.4	0.0	0.0	0.0	0.0	0.0	0.0				
Per hectare per year	-2.9	-2.9	0.0	0.0	0.0	0.0	0.0	0.0	-2.9	-2.9	0.0	0.0

Table 9. EX-ACT summary for Intervention 7

Project Name	Philippines	Climate	Tropical (Wet)	Duration of the Project (Years)	20		
Continent	Asia (Insular)	Dominant Regional Soil Type	HAC Soils	Total area (ha)	50000		
Components of the project	Gross fluxes		Share per GHG of the Balance		Result per year		
	Without	With	Balance	All GHG in tCO2eq	Without	With	Balance
	All GHG in tCO2eq			CO2	N2O	CH4	
	Positive = source / negative = sink			Biomass	Soil	Other	
Land use changes	Deforestation	0	0	0	0	0	0
	Afforestation	0	0	0	0	0	0
	Other LUC	0	0	0	0	0	0
Agriculture	Annual	0	0	0	0	0	0
	Perennial	-2,000,333	-2,226,658	-226,325	-226,325	0	0
	Rice	0	0	0	0	0	0
Grassland & Livestocks	Grassland	0	0	0	0	0	0
	Livestocks	12,474,306	12,474,306	0	0	0	0
Degradation & Management	Forest degradation	0	0	0	0	0	0
	Peat extraction	0	0	0	0	0	0
	Drainage organic soil	0	0	0	0	0	0
	Rewetting organic soil	0	0	0	0	0	0
	Fire organic soil	0	0	0	0	0	0
	Coastal wetlands	0	0	0	0	0	0
Inputs & Investments	0	0	0	0	0	0	0
Fishery & Aquaculture	0	0	0	0	0	0	0
Total	10,473,972	10,247,647	-226,325	-226,325	0	0	0
Per hectare	209.5	205.0	-4.5	-4.5	0.0	0.0	0.0
Per hectare per year	10.5	10.2	-0.2	-0.2	0.0	0.0	0.0