Working document EX-ACT VC case study

Banana Value chain in Peru

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EX-ACT B-VC	:	Ex Ante Carbon Balance Tool for Banana Value Chain
INIBAP	:	International Network for the Improvement of Banana and Plantain
Ha	:	Hectare
tCO2-e	:	Ton of CO2 equivalent
USA	:	United States of America
US$	:	US dollars
Yr	:	year

1. Introduction

This working document presents a case study of a multi-impact appraisal of the banana value chain in Peru. It allows users to concretely appreciate the functioning of the EX-ACT B-VC, which is a tool derived from EX-ACT, specific for banana value chain, adapted according to the demand of the World Banana Forum. It provides a multi-impact appraisal of the banana value chain in terms of climate mitigation and resilience and also the socio-economic performances of the banana chain analysed. It gives the background on banana value chain in Peru and guidance for the users to use the tool.

1.1. Objectives

The main objectives of this case study is to test the tool, to verify whether the results are acceptable and to illustrate how it is possible to analyse a value chain by using EX-ACT B-VC. Moreover, it can help users to understand the multi-impact appraisal issued from a specific analysis (although simplified).

1.2. Data collection:

For this application on EX-ACT B-VC, the data have been collected from a project financed by Agrobanco in Peru aimed at developing the organic installation which is worth more than 17,000 US$. Prices for the socio-economic analysis have been exported from different other sources.

2. Background:

Considering the high quantity of chemical input used in banana plantation, high social and environmental negative impact can be highlighted in the conventional banana sector (FAO, 2008). Input costs, low access to market, low-input agriculture, dry climate, water resource, and low incidence on pest and disease in the Northern region of Peru facilitate organic banana cultivation. (Luske, 2010)

The Peruvian banana sector grew in a spectacular way from an export value of 2.5 million US$ in 2001 to more than 100 million US$ in 2014, riding the wave of an increasing market demand for organic and Fairtrade bananas in Europe and the USA. This development has a tremendous impact on the local economy in the region. At the same time, the sector is fragmented, relatively inefficient and is vulnerable for external disruptions.

According to Peru's Ministry of Agriculture, over 270 000 hectares were cultivated organically (certified or in transition) by some 33 000 farmers in 2005.

According to USDA (2008), total organic exports reached US$ 220 million in 2007, making Peru the world's seventh largest organic exporter. Organic products as a whole are Peru's third largest agricultural export (behind coffee, asparagus and cocoa).

Organic bananas rank second after organic coffee and account for 19 percent of Peru's organic exports in value. Organic banana cultivation started at the end of the 1990s, when the Ministry of Agriculture launched a programme to convert banana farms to organic agriculture in the Northern Coast area with support from the International Network for the Improvement of Banana and Plantain (INIBAP).

As consumer interest in organic products rises and new organic production and marketing systems keep evolving, organic agriculture continues to rapidly expand.

This case study compares the economic performance, the carbon footprint and the climate resilience generated by upgrading banana value chain, of two different types of production: conventional production and improved organic production with the EX-ACT B-VC tool.

This case study is analyzed with the specific EX-ACT banana value chain tool but can be easily transferred to the EX-ACT VC tool.

3. Methodologies and tool used:

EX-ACT B-VC is a tool derived from EX-ACT (Ex-Ante Carbon Balance Tool), developed by FAO in 2009. EX-ACT VC is an agricultural-forestry, land use, processing and transportation framework of 8 Excel modules that provides co-benefits appraisal of crop-based value chain in developing countries on GHGs emissions, climate resilience and income.

The EX-ACT B-VC aims at helping designing performant and sustainable banana value chains. The methodology provides here both a quantified socio-economic appraisal of value chain at micro and meso level (by agent, by group and for the whole chain) and an environmental carbon-balance appraisal of the value chain impact, in terms of climate mitigation, adaptation and value chain resilience. Thus:

- The **impact on climate mitigation** is reflected through quantitative indicators, derived directly from the EX-ACT tool. These indicators are used to obtain and analyse the mitigation impacts in terms of tCO2-e of the project. The carbon footprint of the product is calculated for the whole value chain and at different needed stages, aiming at analysing the environmental performance of the chain. The equivalent economic return is also determined and could be an important aspect to be considered when attempting, for example, to access to payments for environmental services.
- **Value chain resilience** is assessed using simple quantitative but also qualitative indicators. Adaptation indicators measure the reduction of vulnerability of people, livelihoods and ecosystems to CC.
- S**ocio-economic impact** of the value chain is assessed in terms of value added, income and job generated using a socio-economic appraisal of the value chain.

4. Banana value chain in the current situation:

This analysis only concerns a project of 2,000 hectares in the region of Piura in the North of Peru in South America, where agro-ecological conditions are adapted to banana plantation. The average farm size is small, as 88 percent of the farms have less than 5 hectares in Peru and this segment of the value chain concerns 1,200 beneficiaries/farmers.

The analysis is realized on a time period of 10 years, starting in 2015. Banana plantation is just a part of the income generated at a farm level, rather source of income diversification. We only consider, in this case study, the part of banana plantation in the farm. Traditional banana plantation are present on 1,000 ha with residue burnt, at the origin of a high level of emission. With this type of production, and the low level of agricultural inputs, farmers could only produce small amount of banana per hectare, representing 15 T/ha.

After being harvested, bananas are transported to the packaging facility in the banana plantation by animals (mules), where they are checked and packed in plastic bags and boxes. In the packaging facilities the bananas are transported on conveyer belts powered by electricity. The main use of electricity is for lighting and for operating the pumps that extract water from the wells. The electricity is taken from Costa Rica. We assume that 98% of the production is packed, while only 2% is self-consumed by local population.

Figure 1: Packaging module

5.1 - Energy consumption at packaging level	Current situation	VC upgrading scenario		Emissions factors (TCO2 eq)
Electricity use *(KW / ton)*	13.9	13.9	Costa Rica	*0.015*
Fuel / gas consumption (L/ton)				
Gas (LPG/natural)	0	0		*0.02*
Gasoil/Diesel	0.11	0.11		*2.62*
Gasoline	0	0		*2.87*
Pls specify here if other	0	0		

5.2 - Other input and consummable	Current situation	VC upgrading scenario	Emissions factors (TCO2)
Type of packaging	*kg / ton of product*		
Wood (pallet)	0	0	*0.44*
Paper and card	0	0	*2.1*
Plastics LLDPE	1.4	1.4	*2.5*
Specify here if others			
Boxes	70	70	***1.2***
Description	0	0	***0***

After packing, the bananas are transported to the container terminal yard, mainly by truck, using refrigeration systems. Then, containers are transported to the importing country by ship, using refrigeration from Peru to Germany. Once in the country, bananas are transported by truck in the ripening facilities and then to the retailers.

Figure 2: Transport module

6.1 - Type of transportation			
	Place of departure	Type of transport	Nb of km
1	Farm	*Between 1 and 2*	
		Please select type of transport	0
2	Packaging		
		Truck in country	70
3	Harbour initial		
		International water container	8000
4	Harbour final		
		Truck out country	60
5	Wholesaler (ripening)		
		Truck out country	60
6	Retailers		

6.2 - Conditionning during transportation	
Emission factor for refrigeration (TCO2 eq / ton of product)	
Truck transport	0.00122
Sea transport	0.00183

5. Upgrading project scenario:

This project aims at **implementing improved organic banana plantation** in Peru. Different activities are realized in this project. The first one concerns the plantation of 2,000 hectares of banana on degraded land. The second one, the improvement of banana plantation with improved agronomic practices and manure application on 1,000 hectares in the region of Piura. These two activities concern two modules in the EX-ACT B-VC tool: **Land use change** and **Agricultural practices**, which can be filled up as follows, for both situations.

Figure 3: Agricultural practices module, section non forest land use

Fill with your description	Area transformed (ha): Current situation	Area transformed (ha): Upgrading project	Initial land use	Final land use	Fire Use?
New organic banana plantation	0	2000	Degraded Land	Annual Crop	NO

3.1.1 Annual banana system :	Intercrop (if any)		Banana management options (Definition)							Areas concerned (ha	
	Type of crop	Residue management	Improved agronomic practices	Nutrient management	NoTill./ residues management	Water management	Manure application	Residue management	Yield per ha (T)	Current situation	Upgrading project
Annual crop generated from LUC	None	Please select	Yes	?	?	?	Yes	Please select	30		2000
Annual crop staying as annual:											
Banana trad	None	Please select	?	?	?	?	?	Burned	15	1000	0
Banana organic	None	Please select	Yes	?	?	?	Yes	Retained	30		1000

As it is stated above, the land use change from degraded land to annual crop is automatically integrated in the agricultural practices module "Annual crop generated from LUC". Users do not need to enter data at this level, except the ones concerning banana management options and yield.

The improvement of banana plantation also means a better access to fertilizer and application of manure for banana farmers. An increase of organic fertilizer consumption, associated to a decrease of inorganic fertilizer and pesticides and the implementation of improvement practices are at the origin of an increase of yield up to 30T/ha. However energy consumption in liter per hectare does not change within the upgrading project scenario. The module concerned in EX-ACT B-VC is the **Production input module** and can be filled up as follows.

Figure 5: Production input module

4.1 - Energy consumption at production level :

Energy consumed l/ha	Current situation	Upgrading project		EF (TCO2eq)
Gasoil/Diesel	7.00	7.00		2.62
Gasoline	33	33		2.92
Gas (LPG/ natural)	0	0		0.00
Pls fill if other *(ex. Kerosene)*				
Electricity (Kwh / year)	0	0	Costa Rica	

4.2 - Fertilizer consumption at production level :

List of specific fertilizers (kg/ha/an)	Specify NPK parts (%) N	P	K	Current situation (Kg/ha)	Upgrading project (Kg/ha)
Please enter your specific NPK fertilizer					
Urea	47%			250	0
Lime				0	1000
Sewage	5%	N		0	0
Compost	4%	1.5%	1.2%	0	2000
haifa MAP	12%	61%	0%	100.0	0.0
Multi K	13%	0%	46%	400	0
description	46%	13%	0%	0	0
Description	0%	0%	0%	0	0
Pesticides					
Herbicides (kg of active ingredient per year)				6.7	0.0
Insecticides (kg of active ingredient per year)				1.2	0.0
Fungicides (kg of active ingredient per year)				1	0

Only a decrease in production loss at packaging and transportation level from 3% to 1% and from 4% to 2% respectively can be applied in an upgrading scenario, thanks to a better management of the production. Neither packaging nor transportation inputs change within the upgrading project scenario.

6. Socio-economic analysis & Climate resilience:

Every data entered in the previous module is set out in this economic module. Users only have to enter prices corresponding to the different inputs used for this banana production, labor and other costs per operator at the different levels of the value chain (Production, packaging, marketing/wholesaler) and in local currency. Because of the improvement of the banana production, more labor force is needed. The number of man-day per hectare is consequently more important for certain activities such as weeding-treatment or manure and compost delivery, as you can see below.

Figure 6: Economic analysis module, section Production

Current situation					Upgraded value chain		
Fuel consumption					*Fuel consumption*		
Gasoil/Diesel	7.0		5.775	12.3	Gasoil/Diesel	7.0	12.3
Gasoline	33.0		2.838	28.4	Gasoline	33.0	28.4
Gas (LPG)	0.0			0.0	Gas (LPG)	0.0	0.0
Pls fill if other (ex. Kerosene)	0.0			0.0	Pls fill if other (ex. Kerosene)	0.0	0.0
Labor per ha (man-days)	*enter also labour*				*Labor per ha*		
Land preparation-tillage	10	*MD/ha*	17	50.0	Land preparation-tillage	5	25.0
Seeding- input procurement	10		17	50.0	Seeding- input procurement	8	40.0
Weeding - treatment	8		17	40.0	Weeding - treatment	15	75.0
Manure- compost delivery	10		17	50.0	Manure- compost delivery	15	75.0
Harvesting- farm transport	8		17	40.0	Harvesting- farm transport	10	50.0
Other tasks	8		17	40.0	Other tasks	10	50.0
Total	54				Total	63	

The multi-criteria qualitative assessment for climate resilience induced by the upgrading project scenario has to be filled by the users according to the extent in which the upgrading of this banana value chain improves the buffer capacity of the banana value chain to natural shocks of the banana production, of the households in relation to food security, the resilience and the self-organization of households and the market resilience and the adaptation capacity to the value chain. An assumption for every sub-index was done in this case, but this can be subject to discussion. (E.g. Appendix 1)

7. Results:

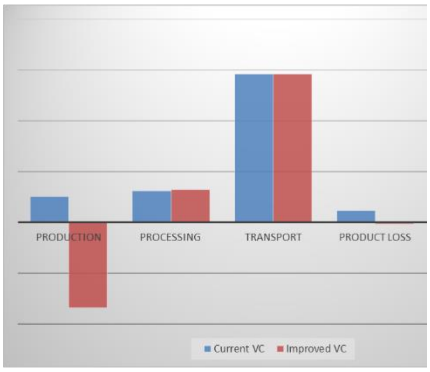
7.1. Climate mitigation dimension:

In terms of GHG emissions, the current value chain is a source of emission of 3,885 tCO_2-e/yr, or 1.3 tCO_2-e/ha. The improvement of this segment of the banana value chain in the region of Piura creates a sink of 31,609 tCO_2-e/year. This result corresponds to a global reduction of the emission of 35,495 tCO_2-e/year, or 12 tCO_2-e/ha. To better assess the economic value of this mitigation dimension, a 10US$ price of carbon has been chosen. The equivalent value corresponding is about 188 US$ per year and per ha, that could be used, for instance, to implement payment for environmental services.

A detailed carbon footprint is given to help assessing which level of the production is the major source of GHG emissions and where actions can be taken to reduce those emissions.

Figure 7: Detailed carbon footprint

Carbon footprint at the different levels of the Value Chain	*Emissions (tCO2/t product)* Current VC	Improved VC	Mitigation impact
PRODUCTION	0.259	-0.843	-1
PROCESSING	0.312	0.320	0
TRANSPORT	1.465	1.465	0
PRODUCT LOSS	0.120	-0.013	0
RETAIL	0.000	0.000	0
TOTAL	2.156	0.930	-1



Upgrading the production of banana by implementing new practices reduces considerably the carbon footprint of 1 tCO2-e/ton of banana produced. However, the transportation of banana remains the major source of GHG emissions and the total carbon footprint stays high even if the production is improved. Effort should be made at this level in order to decrease the distance travelled by banana. Giving better access to local markets, for instance, rather than exporting banana could reduce GHG emissions. Another analysis could be realized for this type of value chain.

7.2. Climate resilience:

In terms of quantitative appraisal of the value chain resilience, there is 1,000 ha that are managed with increased soil carbon. Those practices allow to increase the resilience in terms of drought and erosion in the banana plantation. Moreover, this scenario benefits 1,200 households that are becoming more resilient.

In terms of qualitative appraisal, the results show that the global climate resilience generated by the value chain is low. This could be explained by the low buffer capacity of the banana plantation. To increase the level of resilience, agroforestry system could be considered, allowing to improve land cover, as well as soil erosion, soil conditions,…and so on.

7.3. Socio-economic performances:

The global socio economic performance induced by upgrading the value chain denotes a better performance in terms of creating wealth and distribution of income at every stage of the banana chain. Indeed, the organic installation creates an incremental value added of more than 46 million US$ and an incremental gross income of more than 45 million US$ for this whole segment of banana value chain. Since the costs are less in proportion with the production level, the value added increases of 39 US$/tons for the production, giving access to a higher gross income for the different beneficiaries (+28%). Since packaging doesn't change, the value added remains the same, but the gross income increases thanks to a higher productivity (reduction of production lost and more tons per operator collected and processed).

At every level of the value chain, an important increase in the employment generated can be highlighted and especially because the production is higher and needs more work force for the banana plantation and consequently for packaging and transportation.

8. Conclusion:

Implementing new systems in Peru has a positive impact both in terms of environmental performance with a diminution of GHG emissions, and in terms of socio-economic performances. Organic management in banana plantation give a higher income to farmers and other operators in the value chain by creating higher value added which is at the origin of reducing poverty. This implies a better distribution in the revenue and consequently a reduction of poverty in the rural areas where banana is produced.

However, those results have to be attenuated since we consider only one value chain but is not the lonely source of income generated for a farmer.

Reference:

FAO. (2008). Certification in the value chain for fresh fruit. The example of banana industry.

IPCC. (2006). GIEC Guidelines for National Greenhouse Gas Inventories, Volume 4.

IPCC. (2007). "Agriculture," in Climate Change 2007: Mitigation.

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USDA. (2008). Peru, Organic Product Update. USDA Foreign Agricultural Service.

Appendix

	7- Qualitative appraisal of climate resilience induced			
	Data entry for qualitative appraisal of climate resilience induced by project to be done in light blue cells			
	Buffer capacity of watershed, landscape and project area	**Expert group Assessment (0-4)**	*Indicator Weighting (0-3)*	
1	To what extent does the project improve land cover? (e.g. agroforestry, cover crops etc.)	0	*3*	
2	To what extent does the project reduce soil erosion?	3	*3*	
3	To what extent does the project improve soil conditions (e.g. soil moisture, soil structure etc.)?	2	*3*	
4	To what extent does the project improve efficient use of water?	1	*2*	
5	To what extent does the project save water?	0	*2*	
6	To what extent the project area is protected from climate shocks	0	*2*	
7	To what extend the project infrastructure - building investments are climate-proof	0	*2*	
	Sub-Result	**17**	**low**	*34*
	Buffer capacity of crop production	**(0-4)**		
8	To what extent does the project reduce crop failure?	1	*2*	
9	To what extent does the project improve resistance of crops to pests and diseases?	1	*0*	
11	To what extent does the project reduce post-harvest losses?	2	*2*	
12	To what extent does the project increase practice of mixed cropping/intercropping?	0	*3*	
13	To what extent does the project promote on-farm **diversity** (annuals/perennials, mixed cropping, mixed farm enterprise e.g. livestock-crop)?	0	*3*	
14	To what extent does the project reduce yield variability?	2	*3*	
	Sub-Result	**12**	**very low**	*26*
	Buffer capacity of households in relation to food security	**(0-4)**		
15	To what extent does the project improve household food availability (e.g. through increased household	1	3	
16	To what extent does the project improve household food storage	1	2	
17	To what extent does the project improve household income?	4	3	
18	To what extent does the project increase agricultural production physical assets?	2	2	
19	To what extent does the project improve access of households to agricultural inputs?	1	2	
20	To what extent does the project support (existing or new) farmer groups and networks?	0	2	
21	To what extent does the project increase agricultural skills?	3	2	
22	To what extent does the project improve access of households to climate-related social safety nets	2	2	
	Sub-Result	**33**	**0**	*30*
	Self-organisation of households	**(0-4)**		
23	To what extent does the project improve cooperation and networks of farmers (e.g. farmer groups,	1	*1*	
24	To what extent does the project collaborate with national/sub-national farmer/pastoralist organisations	1	*1*	
25	To what extent does the project support farmer-networks across scales (e.g. local farmer groups being connected to national farmer organisations; bridging/linking social capital)?	0	*1*	
26	To what extent are farmers actively participating in the project?	4	*2*	
27	To what extent does the project foster good governance (keeping of records; accounting for exclusion, elite capture and corruption) in farmer cooperation and networks?	4	*2*	
28	To what extent does the project improve farmer skills to manage groups?	1	*2*	
29	To what extent does the project link agriculture value chains?	4	*1*	
30	**On-farm reliance**: To what extent does the project build on local knowledge?	4	*1*	
	Sub-Result	**28**	**medium**	*20*
	Learning capacity of households	**(0-4)**		
31	To what extent does the project improve farmer knowledge of threats and opportunities to agricultural production (e.g. climate specific awareness programmes)?	4	*2*	
32	To what extent does the project improve access to extension services?	1	*2*	
33	To what extent does the project improve farmer/pastoralist experimentation (e.g. through	0	*0*	
34	To what extent does the project improve access to climate information (e.g. seasonal forecasts adapted for agriculture, workshops)?	3	*2*	
35	To what extent does the project improve access to market information?	1	*2*	
36	To what extent does the project improve access to communication networks (e.g. mobile networking, radio programmes)?	0	*2*	
	Sub-Result	**18**	**low**	*20*
	Total resilience index	**108**	**low**	*130*