Practical guidance for using EX-ACT B-VC tool for Banana Value Chain

(EX-ACT B-VC)

Abbreviation list

CC: Climate Change

CO_2: Carbon Dioxyde

CH_4: Methan

CSA: Climate Smart Agriculture

EX-ACT : Ex Ante Carbon balance Tool

FAO: Food and Agricultural organization from United Nations

GI: Gross Income

GHG: Green House Gases

GPV: Gross Production Value

Ha: hectare

IPCC: Intergovernmental Panel on Climate Change

LED: Low Emission Development

PV: Production Value

Q: Quantity

SFVC: Sustainable Food Value Chain

SO: Strategic Objective

t: ton

tCO_2: Ton of CO_2

tCO_2-e: Ton of CO_2 equivalent

US$: United State Dollars

VA: Value Added

VC: Value Chain

UNFCCC: United Nations Framework Convention on Climate Change

WBF: World Banana Forum

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This manual presents how to use the EX-Ante Carbon-balance Tool for Banana Value Chain, known as "EX-ACT B-VC", to provide a multi-impact appraisal in terms of socio-economic and environmental assessment for the banana value chain analysis. It also introduces the major challenges in the banana sector, the recent World Banana Forum initiative, its implication for developing such a tool and a background on sustainable food value chain.

Chapter 1: Introduction

1.1. The banana sector: environmental and socio-economic challenges:

Bananas are the world's most exported fresh fruit both in volume and value. This fruit is exported primarily from developing countries to industrialized countries, the latter accounting for close to 90 percent of world net imports. 107 million tons of banana were produced in 2011, in more than 130 countries around the world corresponding to 9 billion USD (FAO, 2013). The banana market is characterized by heavy horizontal and vertical integration within the value chain and a low-cost and highly competitive export market focused in Latin America.

Bananas are typically grown on monoculture plantations, where viruses, pests and fungi spread in epidemic proportions over the last decades, at the origin of an increasing dependence on agrochemicals (Mlot, 2004). Use of unsustainable production and trade methods have contributed to the depletion of natural resources and have had negative impacts in terms of health safety, especially concerning farmers, workers, their families, and local communities. A high amount of pollution caused by the intensive use of agrochemicals in monoculture production remains an important challenge also affecting productivity (Liu, 2009). Because of an oversupply in the banana sector, market liberalization in the European Union, strong economic growth in emerging market, and strong and unusual climate event, a recurrent price fall occurred in the last decades, and have slowed the growth of banana consumption, impacting significantly the overall economy in some countries banana-based producers.

Moreover bananas are essential sources of income and employment for hundreds of thousands of households in developing countries, notably in Latin America, the Caribbean, Southeast Asia and West Africa. But the different issues encountered in this sector, due to agrochemical-intensive banana production on large-scale plantations, distortions along the value chain and declining producer prices, have given rise to environmental and social-economic challenges.

According to the 2011 United Nations conference on trade and development, five major companies account for more than 70 per cent of the global banana exporting market serving functions from production to trading bananas, and the decisions related to trading practices seem to determine effectively the sustainability outcomes associated with banana production (Liu, 2009). Strengthening their capacity by developing a sustainable banana sector can help to face these complex international threats.

Therefore, it is necessary to achieve adjustments of the chain from the environmental and socio-economic conditions of the production, through marketing to consumption, with an increasing participatory approach from the different stakeholders in the value chain and by actively supporting their collaboration.

1.2 The World Banana Forum to develop sustainable banana value chain

To meet the multiple and complex international challenges of the banana sector and to promote the involvement of all stakeholders within the chain, a multi-stakeholder Forum on Sustainable Production and Trade have been implemented in 2009 by FAO to lead the organization of an international forum on sustainable production and trade, commonly called World Banana Forum (WBF). The WBF is a space where the main stakeholders of the global banana supply-chain work together to achieve industry-wide consensus on best practices for sustainable production and trade, supporting collaboration as the key of success.

It promotes the worldwide adoption of best practices for sustainable banana production and trade and provides a space where farmer organizations, exporter groups, trading companies, worker unions, fresh produce companies, retailers, governments, research institutions and civil society organizations can discuss the various problems facing the banana sector and jointly seek solutions through collaboration.

Several missions are assigned within this forum and concerning socio-economic and environmental issues encountered and aim at:

- ✓ Developing sustainable banana production and trade
- ✓ Ensuring a fair price for every actors of the banana chain, from producers to retailers, to cover costs and ensures a reasonable profit margin
- ✓ Supporting the respect of the core international labour conventions and pay decent wages for all actors in the chain
- ✓ Quantifying, understanding and optimizing environmental impact on banana production
- ✓ Providing good quality banana to consumers and make them aware of the need to pay a sufficient price that ensure sustainable livelihoods for all actors in the industry
- ✓ Developing dialogue and collaboration to resolve views and interest divergence throughout the banana sector

The Forum focuses its activities in finding practical solutions to field problems. It undertakes projects that can rapidly generate gains for all stakeholders and is specifically specialized in developing the sustainable management of natural resources and promoting mitigation of climate change and uncontrolled environmental impact.

1.3 A specific demand for developing a tool adapted for banana value chain appraisal:

To tackle simultaneously those different issues, the WBF has requested to develop a methodological tool for the measurement of carbon and socio-economic performance that could be specifically adapted to the banana sector. In particular, the main goals were to focus on the carbon footprint in the banana sector, to appraise the potential solutions to tackle sustainability issues in banana production and to develop more sustainable production and trade of bananas throughout the environmental issues, corresponding to the first WBF working group. A second working group have been developed to analyse the distribution of value along the whole banana chain, by mapping it and evaluating prices and costs along the chain. At this socio-economic level, the WBF wanted to develop a practical methodology for approximating living or decent wages at plantation / farm level within the development of indicators and capacity building strategies.

The EX-ACT Banana Value Chain tool, was developed in this sense by the EX-ACT team in order to help current and future stakeholders involved in the banana sector to appraise different socio-economic and environmental performance of the banana chain at the different level thanks to quantitative and qualitative indicators. In particular, the EX-ACT B-VC tool allows to (i) carry out farm level and value chain appraisals, (ii) to stimulate value chain improvements, (iii) to support decision making on value chain upgrading options, (iv) to eventually promote carbon labelling for some value chains.

Chapter 2: The Sustainable food value chain concept

2.1 Development of the Value Chain concept

The value chain concept has been derived for decades from numerous other related concepts, which are used in the literature. From the *Filière* to the value chain, changes occurred over time to address the new stakes into the different notions. For instance, the supply chain concept is mostly concerned with the optimization of the flow of products and services through the chain, while Porter's value chain concept introduces "value chain" as a new term, putting in first place the value addition in competitive markets as the core element in the production-to-consumption chain of activities (FAO 2014).

Derived from this last idea, a value chain is defined as "*the full range of activities that is required to bring a product or service from conception, through the different phases of production, delivery to final customers, and final disposal after use. In the context of food production, these activities include farm production, trade and support to get food commodities to the end-consumer" (Kaplinsky and Morris, 2002).* The value chain analysis allows to identify values added[1] created at each stage of the chain.

[1] It is defined by the difference between the gross value of the product, incorporating the value of all the actors which make up the production, and the wealth which has been consumed in the production process.

The value chain can play a vital role in improving linkages between the different stakeholders in the value chain, ensuring that farmers tailor their production to meet the demands of the market instead of simply looking for a market (Anonym 2012), also for banana value chain. Thus farmers can become more actively engaged in adding value to products by improving quality, packaging and presentation at every stage of the chain. The value chain concept is increasingly supported in international discussion. For instance, an international conference was held in Addis Ababa in 2012 about “Making the Connection: Value Chain for small-holder agriculture”, and attended by more than 500 delegates, where the importance of enabling policy support and infrastructures to allow farmers to be well-placed in national and intra-regional market, and increase the collaboration between the stakeholders has been discussed.

With the need to cope with strategic objectives of FAO and WBF missions, the sustainable food value chain concept has been recently developed and derived from those different notions, targeting the three pillars of sustainable development. This guidance is inspired by the sustainable food value chain concept, but has been adapted for targeting value chain resilience analysis, adaptation and mitigation dimensions, in order to go further in the analysis by integrating the different aspects affecting the value chain performance. In particular, there are many benefits associated with taking a “value chain approach” to climate resilience, since climate change affects food production as well as food industry and it represents important opportunities for lifecycle thinking and creative collaboration.

2.2 Sustainable food value chain and climate resilience

A sustainable food value chain takes into consideration the different dimensions of sustainability in the value chain concept and applies it to the specific nature of food production (banana especially here), processing and distribution. The guiding principles on developing sustainable food value chains, elaborated by FAO in 2014 define this last one as:

“The full range of farms and firms and their successive coordinated value-adding activities that produce particular raw agricultural materials and transform them into particular food products that are sold to final consumers and disposed of after use, in a manner that is profitable throughout, has broad-based benefits for society, and does not permanently deplete natural resources.”

Unlike related concepts, such as the *Filière* / commodity chain and the supply chain, the sustainable food value chain concept simultaneously stresses the importance of three elements. (1) It recognizes that value chains are dynamic, market-driven systems in which vertical coordination (governance) is the central dimension; (2) the concept is applied in a broad way, typically covering a country’s entire product subsector, banana in this case, and (3) value added and sustainability are explicit, multidimensional performance measures, assessed at the aggregated level (FAO 2014).

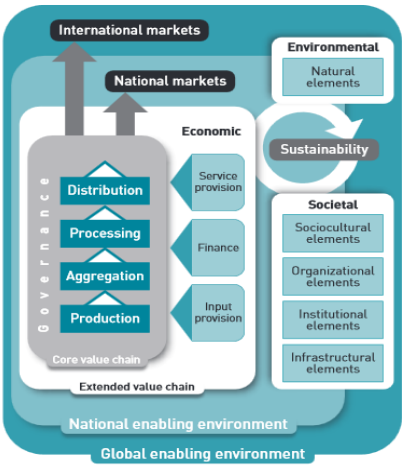
However, in the EX-ACT B-VC tool, we consider besides the sustainable food value chain concept, the introduction of additional dimensions concerning adaptation, resilience and mitigation induced at a value chain level, in order to better manage climate change risks at different levels within the perspective of giving importance to CSA in the analysis of a food value chain.

2.3 Sustainable food value chain framework:

Banana value chains are complex framework analytical tools. Mapping the boarder is indispensable, both as a construct for ensuring analytical clarity and as a useful presentation tool to avoid any misunderstanding. A value chain starts from the product cultivated, here banana, and can be separated in different sub-value chains according to the practices applied, the type of processing and the final product. For instance the banana value chain can be divided into 2 segments: (1) the agroforestry practices (2) monoculture banana plantation. To clearly identify the boarder of the value chain it is important to first consider the different flows and operations taking part in the whole food process. Even though the product cultivated is often used to name the value chain (banana value chain), it seems more relevant to start from the primary agricultural production and follow the product from the upstream level through the different marketing channels and the different stages of transformation up to the markets of realization. Then, it is important to downstream and identify the major inputs and services providers present at the different stages of production (Duruflé et al, 1998). However, the upstream level can put some more difficulties in appreciating the degree of participation from agro-furniture providers in the value chain (fertilizer, pesticides, agricultural machinery…), whether it is relevant or not to consider them in the value chain analysis. Therefore we only consider those agents by whom the product actually transit, included in the value chain boundaries. Following the product, it may also highlight other difficulties in terms of defining the sub-value chain or segment. The logic leads to identify the process until the final consumer, or exportation, since the boarder stops at a market stage, without penalizing the socio-economic analysis.

For this purpose, we consider the sustainable food value framework as a guidance for defining the boarder for analysing the banana chain performance. It is based and related to the value chain actors, i.e. those who produce or procure from the upstream level, add value to the product and then sell it on the next level. In this concept four core functions are distinguished in the chain: production, aggregation processing and distribution (wholesale and retail), in a national and global environment, considering natural and societal elements as well as local, national and international market. (See figure 8 below) (FAO 2014).

Figure 1: The sustainable food value chain framework



This framework allows to work out most of the criteria used to identify a growth engine sector and to analyse the potential of poverty reduction of an activity. It fits well to assess an engine growth sector in terms of actual situation, potential impact on poverty reduction and to define an agricultural strategy with appropriate policy options.

Chapter 3: EX-ACT B-VC Background

3.1 Objectives:

EX-ACT B-VC is a tool derived from EX-ACT (Ex-Ante Carbon Balance Tool), developed by FAO in 2009. EX-ACT B-VC provides an agricultural-forestry and land use modelling framework of 8 Excel modules to appraise the impact of banana value chain on GHG emissions and carbon sequestration. It indicates effects of different production and processing activities on the carbon balance.

The EX-ACT B-VC aims at helping designing banana value chains that are performant and sustainable. The methodology provides here both a quantified socio-economic appraisal of the 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 term 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 tCO_2 of the value chain and of an upgrading project scenario. 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.

- The **Value chain resilience** is assessed using simple quantitative but also qualitative indicators. Adaptation indicators measure the reduction of vulnerability of people, livelihoods, ecosystems and market to CC.

- The **Socio-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.

Therefore, the EX-ACT B-VC tool is of high interest for WBF and every stakeholder is involved in the banana sector to:

- pre-assess what impact they may reach (ex-ante appraisal) in a given time framework at a value chain level;
- monitor their progress in achieving selected objectives at different points in time and at different scale of the chain;
- evaluate (ex-post assessment) the achievement of stated objectives.

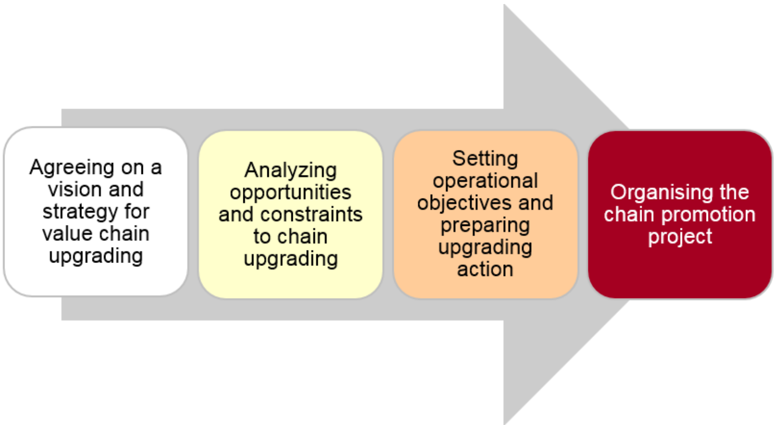
3.2. EX-ACT B-VC boundaries:

EX-ACT B-VC does permit the analysis from production to retailers, comparing two scenarios: the current situation of the value chain and an upgrading project scenario based on the analysis of agricultural production, land use change, processing, packaging and transportation of agricultural products. This tool only concerns crop production. Fisheries and livestock value chain will be developed soon.

The current situation of the value chain corresponds to the current production, type of processing and transportation, characterising the analysed value chain.

The upgrading scenario denotes the development path of the banana value chain and aims at improving it in terms of climate mitigation, adaptation, value chain resilience and socio-economic performance. It could cover three different aspects. (1) "Product upgrading" that is the innovation, diversification or improvement of the final product (2) "process upgrading", which is the improvement of production and distribution technology and logistics, and (3) "Functional upgrading" which means the shifting of value chain functions from one VC operator to another (Bockel 2009). Upgrading implies activities in different fields of action that can be summarized as "improving business linkages, associations and partnerships, strengthening service supply and demand, introducing standards, improving policies and the business environment of the banana chain, expansion or productive capacity which enhances the volume sold. To build a value chain strategy, a sequence of steps are implemented, described in the following figure.

Figure 2: Steps for building a value chain upgrading strategy



From the WBF point of view, it is important to make sure that the vision and strategy are formulated and shared by all stakeholders in the banana value chain, to increase the participatory approaches and partnership.

The multi-impact appraisal provided by EX-ACT B-VC compares both situation, while the current situation is used as the baseline scenario. The improvement of the value chain can be presented at any level of the chain.

EX-ACT B-VC had been adapted and retargeted in order to analyze the value chains in developing countries. It fits for analyzing either a simple banana value chain, or a segment of more complex banana value chains (regional or specific sub-value chain area). Therefore, it is possible to analyze a complex value chain, by fragmenting it in segments, providing an impact appraisal for each of the segment and finally aggregating the results.

3.3. Methodology:

The performance of sustainable banana value chain is generated at different dimensions that are tackling simultaneously in the tool. The value chain presents challenges and opportunities to make progress in de-carbonizing banana production and reducing carbon emissions at the different stages of the chain but also in terms of increasing resilience of local population directly dependent on the banana sector. Adaptation and mitigation options are two strategies at a value chain level against CC and vulnerability of the population in terms of risks, shocks and long-term climate variability, and have a real impact in terms of food value chain performances. This environmental performance is complementary to the socio-economic performance of the chain. It is mostly generated by wealth accumulation, number and nature of direct and indirect jobs related and the improvement of food supply aiming at meeting food demand in rural as well as urban areas. Defining a food value chain sustainably means taking into account all these dimensions and being able to quantify and analyse its performance.

This proposed methodology is a first analytical framework on possible mitigation, adaptation and resilience indicators to include in a monitoring system for analysing banana value chain. It is based on the need for simple mitigation, adaptation and resilience indicators, easy to collect and to aggregate, which develop a measurable and concrete tracking system, in order to elaborate an accurate assessment of the impact of value chain.

3.3.1. Methodology for climate mitigation dimension analysis

Climate mitigation consists on reducing rhythm and magnitude of environmental changes, here considered at the whole value chain level. It aims at reducing GHG emissions and increasing carbon sequestration of carbon, by improving practices at the different stage of food production (improving agricultural practices, reduction of production wasted…).

Several methodologies are used for the calculation of GHG emissions at the value chain level.

Climate mitigation is computated using the framework of EX-ACT version 7 for the agricultural production part. Emissions factors and default values come from IPCC (2006), which has drafted a methodological guidance to estimate CO2 emissions for the different steps of the crop production. It has been completed with other existing methodologies, such as embodied GHG emissions for farm operations, inputs transportation, and irrigation systems implementation from Lal (2004). For more details about the computation of GHG emissions, please refer to the technical guideline of EX-ACT[2].

[2] http://www.fao.org/fileadmin/templates/ex_act/pdf/Technical_guidelines/EX-ACT-tech-guidelines_V4.pdf

Concerning banana processing and transportation, GHG emissions are mainly associated with energy use, such as fuel consumption, electricity and conditioning. Therefore, the straightforward approach is to estimate CO_2 emissions for those different steps and multiply the quantity of input per tonne of production by an ad-hoc emission factor.

- For energy use at processing level, the emission factor remains the same than for crop production. Fuel and electricity default data are taken from IPCC (2006).
- For the packaging we currently consider the present values provided by Berneers-Lee and Hoolohan (2012). To simplify the tool, we consider the most wide-spread type of packaging. A Tier 2 option allows the user to enter other types and emission factors associated.
- For refrigeration both in processing and transportation we consider data from Dole (2009) especially computated for banana production. A context-dependent user can enter other emission factors, which are more adapted in a Tier 2 option.
- For transportation we consider emission factors from Weber & Mathews (2008) based on the carbon emission per kilometres.

We currently consider those emission factors but some improvements can be done at this level, considering the region and context of the banana value chain. These default data are globally the averaged value with a high degree of uncertainties, therefore using them might lead to over or under-estimate carbon emissions. The following tab gives the default data used for the two sections:

Table 1: Emission factors adapted for value chain analysis

	Type of packaging tCO2/t of packaging	**Emission factors used**	**Source**
Processing	Wood	0.4	Berneers-Lee and Hoolohan (2012)
	Paper and card	2.1	
	Aluminium	8.5	
	Plastic (mixed)	3.6	
	Conditioning (refrigeration) tCO2 / ton of product	0.00834	Dole (2009)

	Type of transport tCO2-eq/t-km		
Transport module	Truck	0.0018	Weber & Mathews (2008)
	Air	0.0068	
	Rail	0.0018	

	Inland water	0.0021	
	International ship	0.0014	
	Conditioning refrigeration) tCO2 / ton of product	0.00122	Dole (2009)

Results in terms of climate mitigation are derived at a value chain level thanks to a carbon footprint indicator (tCO_2-e/ton of product), giving an environmental quantitative performance of the food production for the whole value chain and for the different stages of the food chain. A decrease of the carbon footprint means an improvement of environmental capacity, raising the performance of the whole value chain in terms of climate mitigation impact and can be an incentive for the banana sector for reducing carbon emissions and environmental negative impacts generated at a value chain level and making food chain more performant (innovations…).

These indicators allow to obtain and analyse mitigating impacts in terms of the project and also tCO2 equivalent economic return, which could be an important aspect to consider when seeking, for example, the access to payments for environmental services.

User can enter in the "Value Chain results" module a carbon cost (US$) to assess an equivalent value of the impact of mitigation per year and per ha: how much money does the upgrading of the value chain allow to gain or to lose?

The impact on the mitigation of climate change is reflected through the following quantitative indicators, derived directly from the EX-ACT tool:

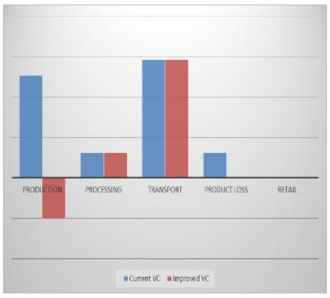
i. Tons of carbon dioxide equivalent (t CO2 equivalent) reduced or avoided (including increased removals) over 20 years;
ii. Mitigation impact in tCO2e per year;
iii. Mitigation impact per year per ha;
iv. Project cost per ton of CO2 equivalent reduced;
v. Equivalent value of the impact of mitigation per year (US$ / tCO2);
vi. Equivalent value of the impact of mitigation per year per ha (US$ / tCO2);
vii. Carbon footprint

Figure 3: Climate mitigation dimension of the value chain

Price tCO2	10 US$			
Climate Mitigation dimension of the value chain (s)	Current situation	Value chain upgrading project	Mitigation impact	
GHG impact in tCO2-e per year	190	-174	-365	TCO2/ year
GHG impact in tCO2-e per year per hectare	6	-5.81	-12	TCO2/ha
Carbon footprint per tonne of production, in tCO2-e per tonne of product	1.3	-0.51	-2	TCO2/ t of product
Incremental in tCO2-e [emitted (+) / reduced or avoided (-)]		-36		TCO2
Equivalent project cost per tonne of CO2 reduced or avoided, in US$ per tCO2-e		47		US$/TCO2
Equivalent value of mitigation impact per year , in US$ /tCO2-e		365		US$/year
Equivalent value of mitigation impact per year per ha, in US$ /tCO2-e per year per hectare		122		US$/year / ha

Figure 4: Detailed carbon footprint

Carbon footprint at the different levels of the Value Chain	Emissions (tCO2/t product)		Mitigation impact
	Current VC	Improved VC	
PRODUCTION	1.268	-0.505	-2
PROCESSING	0.312	0.312	0
TRANSPORT	1.465	1.465	0
PRODUCT LOSS	0.311	0.006	0
RETAIL	0.000	0.000	0
TOTAL	3.356	1.277	-2



3.3.2. Methodology for climate resilience analysis

The EX-ACT VC appraisal of climate adaptation impact should target the incremental resilience generated by upgrading a value chain. Existing methods combine very global quantitative indicators as number of beneficiaries with improved value chain resilience capacity or number of ha with improved resilience to climate shocks. It also uses a set of qualitative indicators to estimate the potential of an upgrading scenario to build resilience, through contributing to the various dimensions of resilience.

Resilience does not derive from one indicator. As such the relative strengths of the resilience dimensions depend on the social-ecological (including political) framing conditions. While buffer capacity largely captures farmers' endowments and access to various capitals, self-organisation and learning include more process-like and practice-like indicators, capturing the agency of the farmers in building resilience. The aim of such resilience appraisal is to judge if and in what dimensions a project might contribute to increase climate resilience of beneficiaries.

(i) Quantitative resilience indicators:

The EX-ACT VC quantitative resilience appraisal allows also at deriving some quantitative indicators for resilience generated either in terms of areas or households benefiting from increased resilience:

i. Increase of hectares of land managed through resilient practices to climate change;
ii. Hectares with improved coverage of trees and vegetation (reduction of landslides and erosion, flood resistance);
iii. Hectares with enhanced carbon content in the soil (resilience to drought and erosion reduction);
iv. Number of households benefiting from improved resilience of watersheds and land to climate shocks;
v. Number of households benefiting from improved resilience of farming systems;
vi. Number of households benefiting from improved physical, social, financial capital;
vii. Number of households benefiting from improved self-organization and learning abilities

In EX-ACT VC, these qualitative resilience indicators appear as follows:

Figure 5: Quantitative climate resilience dimension

Climate Resilience dimension (s)	Current situation	Improved VC	
Hectares of land managed under climate-resilient practices	0	10	ha
Hectares with improved tree and vegetal coverage (land slide, flood resilience)	0	0	ha
Number of hectares with increased soil carbon (drought and erosion resilience)		10	ha
Number of HH having become more climate resilient		6	HH

(ii) Qualitative resilience appraisal:

A more thorough assessment of the adaptation is based on a multi-criteria analysis of different dimensions of resilience issued and derived from a FAO methodical study work (Chinwe Ifejika Speranza). The three identified resilience dimensions are: buffer capacity; self-organization of farmers in the value chain; market resilience and adaptation capacity. These three dimensions of resilience are based on a series of indicators deducted from the project profile. The buffer capacity differs in the three levels of analysis in which an agricultural system can be identified: value chain/area level, households parcel level and production systems. Consequently, the resilience index is based on five resilience factors:

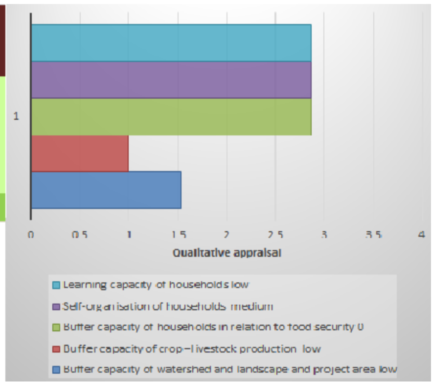
i. Buffer capacity to the value chain to natural shocks
ii. The absorption capacity of climatic shocks of production systems;
iii. The absorption capacity of climatic shocks on household food security;
iv. Strengthening the self-organizing ability of households in the value chain;
v. Market resilience and adaptation capacity to value chain.

A general index derived from these factors, gives a first estimate of the value chain resilience generated by an upgrading scenario, which is measured as very high, high, medium, low, very low. To assess the impact of the project on each of these resilience factors, different criteria are used. Every factor is measured through a set of specific qualitative criteria to be answered. For instance, to assess the buffer capacity of the value chain to natural shocks, a series of seven questions are proposed: (i) To what extent does upgrading the value chain improve land cover? (e.g. agroforestry, cover crops etc.), (ii) To what extent does upgrading the value chain reduce soil erosion?; (iii) To what extent does upgrading the value chain improve soil conditions (e.g. soil moisture, soil structure etc.)?; (iv) To what extent does upgrading the value chain improve efficient use of water?; (v) To what extent does upgrading the value chain save water?; (vi) To what extent the value chain area is protected from climate shocks; (vii) To what extent are the value chain infrastructure - building investments climate-proof ?

The complete detail-list of questions is presented in the tables of data entry provided in chapter 4.1.8**.** Results are aggregated in the "Value Chain results" module as follows:

Figure 6 : Qualitative climate resilience results

Resilience index of the value chain upgrading	Current situation	Value chain upgrading project
Buffer capacity of the value chain to natural shocks		low
Buffer capacity of crop production		low
Buffer capacity of households in relation to food security		0
Resilience and self organization of households		medium
Resilience and self organization of households		low
Global climate resilience generated by Value chain		**medium**



3.3.3. Methodolgy used for socio-economic performance appraisal

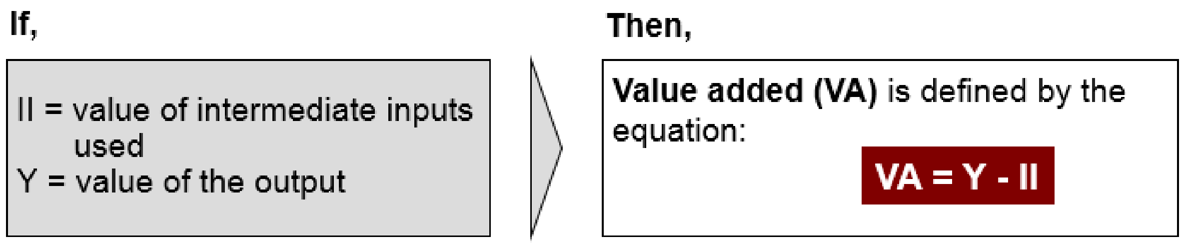
Four main indicators are used for appraising the socio-economic performance of the value chain linked with the concept of pro-poor growth. Growth is pro-poor, it is argued, if it uses the assets that the poor own, if it favours the sectors where the poor work and if it occurs in areas where the poor live. This type of growth has to take into account both relative and absolute poor condition to insure a rapid and equitable growth in the wealth distribution (Bockel & Chand 2004).

(i) Value added

Associated with the concept of value chain and sustainable food value chain, the value added is one of the main concepts used by Porter and FAO (2014). The value added measures the creation of wealth, the contribution of the production process to the growth of the economy.

It is defined by the difference between the gross value of the product, incorporating the value of all the factors which make up the production, and the wealth which has been consumed in the production process (Bockel & Tallec 2005). In other words, the value added is the value that the agents have added, at a stage of the value chain, during the accounting period to the value of the inputs in the process of food production. It is calculated as the difference between the intermediate inputs used and the value of the output after the process.

Figure 7: The concept of value added



Value can be added to an intermediate agri-food product not only by processing it, but also by storing it or transporting it and can increase (decrease) over space and time (FAO 2014), allowing to analyze the redistribution throughout the whole chain.

Value added generated throughout the production of food production, from producers to retailers plays a major role in terms of food value chain performance. Indeed, the value created present at every stage of the value chain may influence the three pillars of a sustainable development: economic, social and environmental sustainability, and directly impact poverty and hunger. Value added has five major components: salaries of workers, tax revenues to the government, return of assets, food supply to consumers and impacts on environment (FAO 2014). Redistribution is thus measured amongst the different agents in the economy: households (the recipients of the return to labour), financial institutions (interest charges), the government administration (taxes) and non-financial enterprises (gross income).

Therefore, it is possible to analyse the impact of an upgrading value chain at a socio-economic level by measuring the increase or decrease of the value added at every stage of the banana value chain. An increase of the value added involve an increase of its different components converging towards the reduction of poverty by increasing food security.

(ii) <u>Gross production value (GPV)</u>

The gross production value is computated at every stage of the value chain by multiplying the production value (PV) in US$ with the tonnage of the production (Q) or the area covered (ha) by the value chain. It is taking into account the amount of production lost during the different phases of the food production process.

GPV (US$) = PV (US$/t) x Q (t)

Therefore it is possible to estimate to what extent upgrading a banana value chain at every stage allows to increase the value of the production. An increase of the GPV can be explained by an increase of the value added. Thus it is possible to identify the impact in terms of poverty reduction, especially thanks to the two following indicators.

(iii) <u>Gross income</u>

As seen previously, an increase of the value added has an impact on the wealth redistribution for the different agents of the economy. The income allows to draw a wealth level as well as a meso and a micro-economic level. It is directly measurable for every agent of every stage of the chain. In order to better understand how this redistribution is done across the chain, we have decided to provide the gross income as results allowing to explain the socio-economic performance.

The gross income or gross profit is the difference between the value added generated at a stage of the value chain and the expenditure on labour, interest charges and taxes. In other words, the gross income represents the return of cultivation, once the costs of production, intermediate inputs, labour costs, interest charges and taxes have been deducted.

The comparison between both the current situation and an upgrading scenario allows to assess to what extent the upgrading scenario increases the available income for every beneficiary. The gross income expresses the economic gain, or loss, to the agent once all current production costs are met.

(iv) Volume of employment generated

Indirectly associated with the value added, the volume of employment generated is however deeply connected. The increase in value added allows to augment the income available for the population and consequently to create new employment on the different stages of the chain.

Applied to agriculture value chains, the volume of employment generated is an important "pro-poor" growth engine, since there is a significant part of rural employment/labor in this sector, in developing countries, where they operate at a local or national level (World Bank 2008). Therefore, agriculture's contribution to economic growth and poverty reduction is greatest in low-income countries where it is an important activity for poor people. The key challenge is to create an environment that enables poor people, particularly those working in small and medium sized farm enterprises, to respond to opportunities presented by growing markets. Moreover, the agricultural growth has a multiplier effect on the rest of the economy. The labor intensity of those multipliers has been emphasized. Empirical evidence is now accumulating that for every job made directly in agriculture, from agricultural growth, two to three jobs are made in the non-farm sector (Mellor 2002).

In order to significantly analyze the employment generated, we developed a different methodology for the different stages of the chain. Two steps allow to computing an equivalent number of employment. A number of man-day is measured according to how many men are required or consumed to perform a task for a stage of the food value chain per day, defined in the tool per ton of production or per hectare. An equivalent return of employment is then calculated, assuming that employees work on average 250 days a year. Therefore it is possible to identify the equivalent amount of employment generated at a value chain level, and the increase (decrease) of employment equivalent compared with an upgrading scenario.

Table 2: Methodology used for analysing the volume of employment at the different stages of the chain

Stages of the chain	Unity	Methodology
Agricultural production	Number of man-day	Every step of the agricultural production is differentiated: from soil preparation to harvest
Downstream transportation	Nb of truck driver equivalent + Number of truck assistant	We assume 1 collector = 1 truck x 100 truckloads / year, estimating the quantity transported by truck
Processing	Number of man-day/ton of production	The type of workers is differentiated: Full time practical workers and managers / Seasonal employee / Family workers
Upstream transportation	Nb of truck driver equivalent + Number of truck assistant	Same computation than downstream transport
Wholesaler	Number of man-day / ton + Number of truck driver and assistant	It takes into account only the number of employees / ton of production Truck driver : Same computation than downstream transport

Retailers	Number of man-day	It takes into account only the number of employees / ton of production

The following tab gives a summary of the different socio-economic indicators that are used in EX-ACT VC:

Table 3: Summary of the economic indicators used in EX-ACT VC

Gross production value
- *intermediate inputs*
= **Value added**
- *labour cost, credit cost and taxes*
= **Gross income**
Total jobs generated
Number of add. Man –days divided by 250

The "Economic analysis" module (details Chapter 4.1.7) allows to compute the costs of every intermediate input at the different stages of the value chain, essential steps to compute all these indicators. Results are then grouped in the "VC results" module for each stage of the value chain, as shown in the following figure:

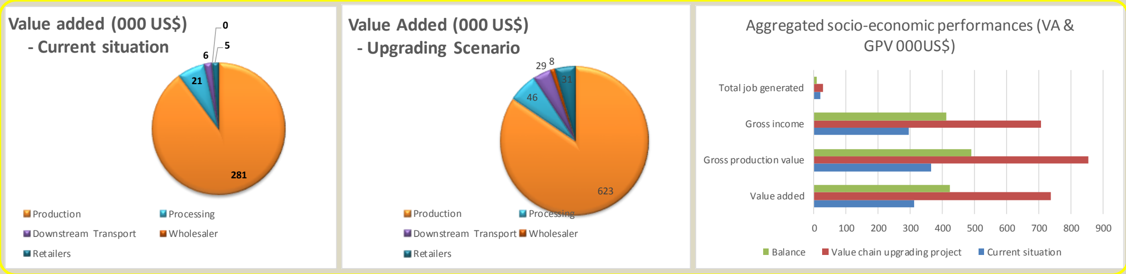
Figure 8: Detailed socio-economic results - example at production and packaging level

Socio-economic performances of the value chain	Current situation	Value chain upgrading project	Balance	
Production level				
Nb of operator eq	9	12	3	jobs
Gross production Value (GPV)	306	684	378	000 US$
Value Added (VA)	281	623	341	000 US$
Gross Income (GI)	272	610	338	000 US$
VA / tonnes of product	735	728	-7	US$
VA / ha	9377	20759	11382	US$
Gross income / farmer - beneficiaries	29745	49022	19277	US$
Packaging				
Nb of operator eq	1	3	1	jobs
Gross processed value	41	92	51	000 US$
Value added	21	46	25	000 US$
Gross income	18	39	22	000 US$
VA / ton of product	55	55	0	US$
Gross income / operator	2932	3025	93	US$

In order to draw the performances of the entire value chain, aggregated results are given following the detailed socio-economic results. To better understand from which stage the value is created, EX-ACT B-VC also gives a detailed value added for both situations, as shown below:

Figure 9: Aggregated results and detailed value added

Aggregated Socio-economic performances	Current situation	Value chain upgrading project	Balance	
Value added	313	737	424	000 US$
Gross production value	365	856	491	000 US$
Gross income	295	708	413	
Total job generated	20	28	8	Jobs created



Chapter 4: Structure of the tool :

4.1 Structure and basic functioning : an easy-to-use tool

The proposed analysis is associated with methods of collection and structured in an Excel file that constitutes the EX-ACT B-VC tool appraised to simplify the analysis and follow-up by upgrading a value chain. The file includes different modules to enter data on value chain, a module on climate resilience analysis, a module on socio-economic analysis and a module of value chain performance results. This proposed methodology is a first analytical framework on possible mitigation, adaptation and resilience indicators to appraise the value chain performance. It is based on the need for simple mitigation, adaptation and resilience indicators, easy to collect and to aggregate, which develop a measurable and concrete tracking system, in order to carry out an accurate assessment of every type of food value chains.

EX-ACT B-VC consists of a set of 8 interlinked Microsoft Excel sheets, (screenshot 1) in which users insert basic data on agricultural management practices, processing and transportation. Users can specify geographical and agro-ecological information concerning the production level, but also data on agricultural practices, processing and transportations of food product.

A navigation bar allows the user to move easily from one module to another. It is presented as follows:

Figure 10: Navigation bar of EX-ACT B-VC

This navigation bar refers to the 8 modules briefly explained in the following tab:

Figure 11: Short description of the 8 modules

1	**General description**	Of the production zone considered and/or upgrading project: Type of Value Chain and/or project, climate, soil, type of vegetation, project area and additional information;
2	**Land use change**	Deforestation, non-forest land use change, new irrigated area;
3	**Agricultural practices**	Annual and perennial crop, flooded rice system, production loss
4	**Production inputs**	Fertilizer and pesticides, energy consumption, infrastructure
5	**Processing**	Energy consumption, production loss;
6	**Transport**	Type of transport and conditioning
7	**Socio-economic analysis**	Price and input cost, labour
8	**Climate resilience**	Qualitative evaluation of project, production and household/beneficiaries resilience.
9	**Value Chain results**	Climate mitigation dimension, climate resilience, socio-economic performance

Those eight modules allow to analyse the current situation of the banana industry and a wide panel of project activities such as developing agricultural production, land use change, rural development project and reduction of production loss at the different levels of the value chain.

Data collection and insertion in EX-ACT B-VC only depend on the type of analysis and thus it is not necessary to complete all the modules within EX-ACT B-VC. At some level, the action plan for an upgrading scenario can also be low, but in order to compare the benefits or not of the upgrading project, it is necessary for users to specify every data for the current situation (which is the baseline scenario) in correspondence of the ones of the upgrading project.

Each EX-ACT B-VC module is sub-divided into its different component using boxes. It is clearly delimited by an outside frame from other sub-module components. A specific color code is used throughout the tool to help users:

Color code	
	It shows where users have to enter data
	Tier 2 option
	Help – additional information: map, definition…

Unit, variables, background

To better understand how the tool is functioning, we base the following module description on an example in banana production in Peru.

4.1. Entry data methodology in the different module:

This part focuses on the analysis of a simple value chain, or a segment of more complex value chains (regional or specific area sub-value chain). For analyzing a more complex value chain, users have to divide it into different sub-value chains and follow the instructions below.

4.1.1. Description module :

This module is the first one that has to be compulsory filled. It has to be filled with central descriptive information on regional agro-ecological conditions. Every user has to start with filling the description module since the rest of the EX-ACT VC otherwise does not contain the necessary input information to proceed. Precisely users should fill in the following information depicted in figure 12, mainly by selecting from drop-down lists.

(i) General value chain information

1 **Location**: Select the continental region in which the analysis will take place from the drop-down list, which will preselect a set of default values for the later emissions calculations.
The eleven continental regions are: *Africa/ Asia (continental) / Asia (India subcontinent) / Asia (insular) / Middle East / Western Europe / Eastern Europe / Oceania / North America/ Central America/ South America*
User can complement with the **country** *(drop down list) and it specifies eventually with* **region** *or* **department** *as well as the municipality.*

2 **Climate***:* The climate is strongly influencing GHG emissions and sequestration in the banana sector. A careful choice of the correct climate information is thus essential. The default options are thereby: *Boreal / Cool Temperate / Warm Temperate / Tropical / Tropical Montane.* The default options of the **moisture regime** are: *Dry / Wet / Moist.*
Dominant soil type*:* users should indicate the main dominant soil type using the simplified IPCC classification. IPCC retains only 6 soil categories: *High Activity Clay soils (HAC) / Low Activity Clay soils (LAC) / Sandy soils / Spodic soils / Volcanic soil / Wetlands soils.*

3 **Type of analysis**: Users have to specify the type of analysis: analysis of the current situation or upgrading scenario.

4 By clicking on the orange boxes this section provides guidance with the help of global maps on which IPCC soils and climate category to use.

Figure 12: Description module

1.1- General Banana VC information

1	Continent	South America		
	Municipality	Piura		
	Country	Peru		
	Region / Departement			
2	Climate	Tropical	Climate	4
	Moisture regime	Wet		
	Dominant Regional Soil Type	Volcanic Soils	Sol	
3	Type of analysis	Upgrading VC project		

1.2- General information on upgrading VC project — **1.3 - Additionnal information**

Please fill only if analysis of an upgrading project scenario

5	Value chain upgrading action	Banana organico installacion		Project budget	17,236 US$
	Project farmers-beneficiaries	6	Households	Name of development bank	Agrobanco
	Duration of the Project (Years)	1	Years (20 years max)	Private investment	NO
	Starting year :	2015		Public investment	NO

(ii) General information on upgrading value chain project

5 Information can be filled up such as the **name of the value chain upgrading action**, the **number of beneficiaries**, the **duration of the project**, the **starting year** of the upgrading scenario, the **project budget**, the name of the development bank and if the project involves or not public and/or private investments.

4.1.2. Land use change module:

This module only concerns upgrading scenario analysis and informs on every land use change induced. It takes into account forest land use change (deforestation/reforestation), non-forest land use change and new irrigated area.

(i) Forest land use change:

Figure 13: Forest land use change section

2.1 - Forest land use change for an upgrading project scenario

1	*Zone 1 = Tropical rain forest*	*Zone 2 = Tropical moist deciduous forest*	*Zone 3 = Tropical dry forest*	*Zone 4 = Tropical shrubland*
	Provide Type of Forest	Forest Zone 2		

Forest land use change	Area affected *(ha)*	Land use change		Fire use ? (yes/no)
Deforestation induced by project implementation	0	Final use after deforestation	Set aside	NO
Deforestation reduced by project implementation	0	Final use after deforestation	Select Use after deforestation	NO
Reforestation activity due to project	0	Initial use before reforestation	Select previous use	NO
Plantation of perennials / conversion to agroforestry	0	Initial use before plantation	Select Initial Land Use	NO

1 **Vegetation type**: Users have to specify the type of vegetation defined as follows for the type of climate: *Forest zone 1: Tropical rain Forest, Forest zone 2: Tropical Deciduous forest, Forest zone 3: Tropical Dry Forest and Forest zone 4: Tropical shrubland.*

2 **Surface area**: Users have to specify the surface area concerned by the change in deforestation (induced or reduced deforestation by upgrading the banana value chain project), or reforestation or conversion to agro-forestry.

3 **Initial/Final land use**: Users have to specify the final state of the land from a drop-down list. It will determine default carbon stocks in the year following the conversion.

4 **Fires use**: Users have to specify whether fire is used or not as a land use change tool

(ii) <u>Non-forest land luse change</u>

This section concerns every land use that can change within an upgrading project scenario in non-forest land. It is presented as follows:

Figure 14: Non-forest land use section

2.2 - Non forest Land use change for an upgrading project scenario

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	20	Degraded Land	Annual Crop	NO
Description	0	0	Select Initial Land Use	Select Final Land Use	NO
Description	0	0	Select Initial Land Use	Select Final Land Use	NO

1 **Description**: Users have to set up the description of the annual systems in order to avoid any misunderstandings in data entry.

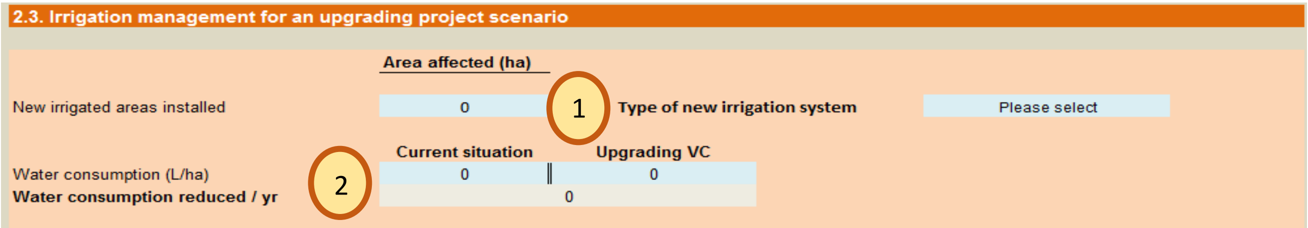
2 **Land use change**: Users have to identify the state of initial and final land use, before and after the upgrading scenario implementation from a drop-down list. This will determine default carbon stocks in the year following the conversion.

3 **Surface**: Users have to specify the surface area of the current situation and with the upgrading value chain project.

> The upgrading scenario wants to implement 20 ha of **new organic banana plantation** coming from degraded land.
>
> *We consider banana as annual crop because it is an herbaceous and not a tree.*

4 **Fire use**: Users have to specify if fire is used as a land use tool for the conversion.

(iii) Irrigation:



1 **Surface and irrigation type:** Users have the surface area under new irrigation practices and the type of new irrigation systems from a drop-down list with implementation of the project.

2 **Water consumption**: Users have to specify the water consumption for both situation. It will be computated the amount of water consumption reduced within an upgrading scenario.

4.1.3. Agricultural practices module:

This module presents two sections. The first one concerns agricultural practices from different types of systems. In mono-cropping or intercropping banana is considered as an annual system, separated in this module from agroforestry system. Agricultural practices that are induced by a land use change or systems remaining the same even with an upgrading project scenario are differentiated.

Users have to complete this module according to the different practices present for the banana production.

(i) Annual Banana system:

Land management practices are important determinants of soil carbon, especially for the annual banana system. It is thus essential to differentiate between the following improved practices:

- **Improved agronomic practices** comprise all practices that may increase yields and thus generate higher quantities of crop residues. Examples of such practices reported by Smith et al. (2007) are the use of improved crop varieties, extending crop rotations, and rotations with legume crops.
- **Improved nutrient management** includes the application of fertilizer, manure or biosolids in a way that improves either the efficiency (adjusting application rate, improving timing and location) or diminishes the potential losses (forms of fertilizer with slow release rate or nitrification inhibitors).
- **Improved tillage and residue management** comprises the adoption of tillage practices of less intensity ranging from minimum tillage to no-tillage. It may include or not include mulching of crop residues and thus also comprises a key element of conservation agriculture.

- **Enhanced water management** consists of enhanced irrigation measures that can lead to an increase in productivity and hence augment the quantity of residues.

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	?	?	?	?	Please select	15		20	
Annual crop staying as annual:												
Banana trad	None	Please select	?	?	?	?	?	Burned	15	10	4	I
Banana improved	Non	ase select	Yes	?	?	?	Yes	Please select	30		6	I
description	Nor	ase select	?	?	?	?	?	Please select				I
decription	None	lease select	?	?	?	?	?	Please select				
description	None	Please select	?	?	?	?	?	Please select				I
** Note concerninf dynamics of change : "D" corresponds to default/linear, "I" to immediate and "E" to exponential (Please refer to the guideline*								Total area	**10**	**10**		

Figure 15: Annual Banana system section

1. **Description**: Users have to set up the description of the annual systems in order to avoid any misunderstandings in data entry.

> *Current situation: traditional banana practices dominate, while under the project improved management practices are implemented.*

2. **Specifying the intercropping system:** If there is any intercropping systems (e.g. banana with maize), users have to select the type of crop from a drop-down list determined from IPCC guidelines: *grain*, *beans and pulse*, *root crops*, *tubers*, *barley*, *maize*, *oats*, *potato*, *soybean*, *wheat;* and the **residue management** of this intercrop.

3. **Management options**: Users have to select the type of management practice non mutually exclusive, that are applied for the system described below:

   Management options: The drop-down list inform on whether one type of management option is realised for one type of crop. A question mark is a default value, corresponding to "NO".

   Residues management: Users have to define which type of residues management is realised for this type of practice (burnt, exported or maintained)

4. **Yield**: Users have to enter the average yield for this crop practice (which will be integrated into the economic analysis)

5. **Area concerned**: Users have to specify the surface area for the current situation and with the upgrading value chain scenario.

6. **Dynamic of change***:* In the small violet boxes users can specify whether the changes in management practices materialize linearly (default) over time, occur immediately or exponentially.

(ii) <u>Agroforestry system:</u>

3.1.2 Perennial systems :	Residue/ biomass burning	Yield (t/ha/yr)	Area concerned: *Current situation*	Area concerned: *Upgrading project*		Tier 2 biomass growth (tC/ha/yr)	Default value
Perennials generated from LUC	NO		0	0			10
Perennials staying as perennials:							
Description #1	NO	0	0	0			0
Description #2	NO	0	0	0			0
Description #3	NO	0	0	0			0
		Total area	0	0	!Total area must remain constant!		

1. **Description**: Users have to set up the description of agroforestry system in order to avoid any misunderstandings in data entry.
2. **Residues management**: Users have to define which type of residues management is realised for this type of practice (burnt, exported or maintained).
3. **Yield**: Users have to enter the average yield for this crop practice, which will be integrated into the economic analysis.
4. **Area concerned**: Users have to specify the surface area for the current situation and with the upgrading value chain scenario.
5. **Tier 2**: A tier 2 option is added in this section concerning the biomass growth for specific agroforestry system. Users have to enter data in tC/ha/yr if it is different from the default value corresponding to the forest chosen.

(iii) <u>Production lost:</u>

The last section of the module concerns the lost and wasted production at a farm level. Users have to enter the percentage lost on average for both situations. This option allows users to analyse whether a reduction in production loss with better production management is at the origin of a mitigation impact.

Figure 16: Production lost and wasted at farm level

3.4. Production loss at a farm level	Current situation	Upgrading project
Percentage of lost and wasted production (%)	15%	5%

4.1.4. Production inputs module:

Entering data in this module on production inputs participate to the calculation of GHG emissions and socio-economic performance. It can be filled either for a current situation or an upgrading situation for banana value chain.

(i) Energy consumption:

Energy consumption is associated to electricity, gas and fuel consumed at the farm scale by mechanization, irrigation or other infrastructure energy-dependant. Users have to specify:

1. Quantity of annual fossil energy consumed for each energy source in m^3 per year and in Kwh per year for electricity in both situation. If renewable energy is used within an upgrading scenario, it is assumed that the consumption of fossil fuel stops and is reduced to 0 m^3 per year.
2. In which country the consumed electricity was produced, since this determines to which extent it is related to GHG emissions. Thereby it has not necessarily to be the country of project implementation.

No change occurs within an upgrading project scenario.

The quantity of gasoil and gasoline remain the same. No electricity is used.

Figure 17: Energy consumption at farm level

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	

(ii) Agricultural Inputs:

This section concerns every inputs directly used in banana agricultural practices (pesticides, fertilisers…)

Figure 18: Fertilizer and pesticides consumption at production level

4.2 - Fertilizer consumption at production level :					
	Specify NPK parts (%)				
List of specific fertilizers (kg/ha/an)	**N**	**P**	**K**	**Current situation (Kg/ha)**	**Upgrading project (Kg/ha)**
Please enter your specific NPK fertilizer					
Urea	47%			250	400
Lime				0	1000
Sewage	5%	N		0	0
Compost	4%	1.5%	1.2%	0	2000
haifa MAP	12%	61%	0%	100.0	180.0
Multi K	13%	0%	46%	400	700
Description	0%	0%	0%	0	0
Description	0%	0%	0%	0	0
Pesticides					
Herbicides (kg of active ingredient per year)				1.0	0.0
Insecticides (kg of active ingredient per year)				1.0	0.0
Fungicides (kg of active ingredient per year)				1	0

1 **List of specific fertilizers:** A specific fertilizers list have been pre-defined but users can add other crop-specific fertilizers by filling the description part.

2 **Specify NPK parts (%):** Associated to the description, users have to specify the nitrogen (N), Phosphate (P) and Potassium (K) shared in the fertilizer, in order to associate the right emission factor.

3 Users have to specify the quantity used in kg per ha, on average for every type of production mentioned in the previous module for both situations.

4 **Pesticides:** Specification in kg of active ingredient per year has to be made for pesticides consumption and for both situations.

> The quantity of chemical input decreases within an upgrading project scenario replaced by an increase in the amount of organic fertilizers (lime and compost).

(iii) Infrastructure construction

If upgrading project implies infrastructure construction, e.g. road or building, users have to choose in a drop-down list the type concerned and fill the area in square meters.

Figure 19 : Infrastructure construction section

4.3 - Other input and consummable

Buildings and roads (in m2)	m2 of buildings
Please select	0
Please select	0
Please select	0
Please select	0
Please select	0
Please select	0
Please select	0

4.1.5. Packaging Module:

Before starting the data entry concerning specific processing, packaging and storage steps, users have to define the percentage of food self-processed and/or self-consumed by local population, which does not necessarily involve local firms. This is important for GHG and socioeconomic analysis. Users have to specify also the percentage of production in the processing activities. Crop being seasonal, the operator can have different types of production.

Before starting

% of production self consumed	2%	*% of production in the processing activities*	100%
% packed	98%		

Figure 20: Upstream data entry in processing module

(i) Energy consumption:

After the production level, only packaging and storage is taking into account in this module. The next section concerns the energy consumption for storing and packaging:

Figure 21: Energy consumption at storage and packaging level

5.1 - Energy consumption at packaging and storage level

Packaging	Current situation	VC upgrading scenario		Tier 2 : Emissions factors (TCO2 eq)	Default value (tCO2-e)
Electricity use *(KW / ton)*	13.9	13.9	Costa Rica		*0.015*
Fuel / gas consumption (L/ton)					
Gas (LPG/natural)	0	0	1		*0.02*
Gasoil/Diesel	0	0			*2.62*
Gasoline	4.8	4.8			*2.87*
Pls specify here if other	0	0			
Storage					
Type of storage			2		
Refrigeration					*0.00834*

	Current situation	Upgrading VC	Unit		
Electricity consumption	0	0	*KW / ton / days*		
Fuel consumption	0	0	*L/ ton / days*	3	
Type of fuel	Peat				0.003
Period of storage	0	0	*Days*		

Since the two steps are or can be unconnected, two sources of energy consumption are differentiated:

` 1 **Packaging:** users have to specify electricity and the country of electricity production, fuel and gas consumption in unit/ton of product. To make this tool more flexible for each type of product, users can specify another type of energy and the emission factor equivalent.

2 **Storage**: it can be more or less long. Users have to specify the **type of storage** considered for this production. Several types of storage are defined in the top-down list: *Refrigeration, involving specific gases at the origin of GHG emission and energy consumption, Ventilation, None, Other*. Users can use the default emission factor or use its own for type of conditioning, which are context-specific.

3 Moreover, users have to specify **electricity and fuel consumption per days** – by choosing in the drop-down list and filling the emission factor corresponding if it is another one. The **period of storage** then has to be necessarily filled, in order to calculate the right amount consumed for this production.

(ii) <u>Type of packaging:</u>

Processing steps also involve other types of inputs and consumable. Users have to specify:

1 **Type of packaging** for transportation and conditioning. Data entry corresponds to the weight of packaging per ton of production. Emission factors are associated to every type of packaging, but users can specify other types of packaging with an emission factor corresponding.

2 **Water consumption** has to be specified in the corresponding section.

Figure 22: Other consumable at processing level

5.3 - Other input and consummable

Type of packaging		**Current situation**	**VC upgrading scenario**		**Emissions factors (TCO2)**
		kg / ton of product			
Wood (pallet)	1	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***
Water consumption					
Volume of water consumption		0	0	L / ton 2	

Plastics and boxes are used for packing bananas before transportation to wholesaler and retailers. Plastics represents 1.4kg per ton of banana.

(iii) Production loss at packaging and storage level

Finally users have to determine the production lost at packaging and storage level for the two situations (if an upgrading scenario is analysed).

Figure 23: Production lost at packaging and storage level

5.4 - Production loss at packaging and storage level		
	Current situation	VC upgrading
Total loss during packaging	3%	1%

4.1.6. Transport Module:

Transportation module corresponds to every step of transportation from farm to retailers that involve different types of transport and conditioning. Three sections are differentiated in this module:

(i) Type of transport and distance travelled:

Figure 24: Transport type and distance section

6.1 - Type of transportation and distance traveled

We assume the transport will not change during the implementation phase

	1 Place of departure	2 Type of transport	3 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

1 **Place of departure:** Via a drop-down list users can choose departure points from every stage of the value chain: *Farm, processing/storage, wholesaler, harbour initial, harbour final, airport initial, airport final, retailers.*

2 **Type of transportation:** The type of transportation has to be chosen also via a top-down list between the two departure points (between point 1 and 2): *Truck in/out country, air, rail, inland water, international ship.*

3 **Nb of km**: Finally, users have to specify the number of kilometres done between point 1 and 2.

The packaging activity is done on the farm. Transportation from the banana field to the packaging facilities are done with animals (mules).

From the packaging facilities to the harbor initial, 70 km are traveled with truck (truck in the country)

8000 km are finally traveled with international ship from Peru to Germany.

(ii) Conditioning during transportation:

Because banana transportation needs refrigeration to limit the ripening, special gases emitting CO_2 in the atmosphere are used.

Users thus have to specify the emission factor for the different types of transportation (ship and truck) according to the country of exportation / transportation.

In this case, both coefficients for truck and sea transportation are taking from Dole banana analysis[3] (2010).

Figure 25: Conditioning during transportation - Transport module

6.2 - Conditionning during transportation

Emission factor for refrigeration (TCO2 eq / ton of product)	
Truck transport	0.00122
Sea transport	0.00183

(iii) Production lost at transportation level:

In the same way as previously, the percentage of production loss at transportation level has to be filled by users for both situations.

Figure 26: Section loss of production at transportation level

6.3 - Production loss at transport level

	Current situation	Upgrading VC scenario
Production loss at transport level	4.00%	2.00%

4.1.7. Socio economic analysis:

This module has been developed in order to be able to analyse the socio-economic performance of the banana value chain. It allows users to enter quantified data on input prices, labour, salary and other costs for the two types of possible analysis.

This module is divided into three sections. The first one concerns the agricultural production, the second one the packaging and storing activities and the downstream transportation. The last one concerns every stage after processing, i.e. the steps concerning the selling of the banana production to wholesalers and retailers.

In order to simplify data entry in the module, prices, costs and salary are specified in local currency. Users only have to enter a **change rate** in order to compute every cost at every stage of the production in US$. Costs are computed by multiplying quantity of inputs, yield or area previously entered in the tool, by prices in local currency assuming that input prices

[3] Luske. Comprehensive Carbon Footprint Assessment Dole Bananas. Dole. 2010

do not change within an upgrading project scenario. However, an option allows to change the selling prices between the two situations (increase of selling prices because of the upgrading of the quality of the product).

Other data, not specified in the other module, such as taxes, renting equipment, maintenance, number of operator, transport capacity of one truck should be specified by users to provide a precise and relevant analysis.

Finally, this module provides the total costs per hectare or per ton of production that will be used to compute the different socio-economic indicators described in the previous chapter.

For example, the section dedicated to packaging and storage is presented as follows:

Figure 27: Processing section in the economic analysis module

Current situation

Additional data		processed	98%	
Nb of operators			6	
Ton per operators			63.75	
Intermediate processing consumption / t of production				
		Unit	Price : local currency)	Production cost (US$)
Energy consumption				
Electricity use (KW / ton)	13.90	*KW*	0.5	1.946
Wood	-	*kg*	0	0
Gas (LPG/natural)	-	*L*	0	0
Gasoil/Diesel	-	*L*	0	0
Gasoline	4.80	*L*	3	4.704
Electricity use for storage	-	*KW*	0	0
Packaging cost				
Wood (pallet)	0	*kg*	0	-
Paper and card	0	*kg*	0	-
Plastic (mixed)	1.4	*kg*	1.5	0.64
Boxes	70	*kg*	2	47.73
Description	0		0	-
Labor per ton of production (man-days)				
Full time practical workers employee	0.4	*MD/t*	25	3
Full time manager employee	0		25	0
Seasonnal employee	0.4		25	3
Familly workers	0		25	0
Total	**0.8**			
Other costs at processing level per ton of product				
Local taxes			7	2.05
Purchase of product			2640	800.00
Total cost per ton of product				863
Other cost per operator				
maintenance of processing equipt +oil			700	212
renewed equipement and plastics			660	200
Building renting			660	200
Stocking chemicals			990	300
Capiltal amortization per year			1300	394
Credit costs			990	300
			Local currency	US$
Ex-factory price / ton of product			3,003	910.0

Upgraded Value Chain

Is only shown data that can be changed within the upgrading project

Nb of operator	13	
	63.75 ton collected	
Intermediate processing consumption / t of production		
	Quantity	Production cost (US$)
Energy consumption		
Electricity use (KW / ton)	13.90000	1.95
Wood	-	-
Gas (LPG/natural)	-	-
Gasoil/Diesel	-	-
Gasoline	4.80	4.70
Electricity use for storage	-	-
Packaging cost		
Wood (pallet)	0	0
Paper and card	0	0
Plastic (mixed)	1.4	0.636363636
Boxes	70	47.73
Labor per ton of production (man-days)		
Full time practical workers employee	0.4	3
Full time manager employee	0	0
Seasonnal employee	0.4	3
Familly workers	0	0
Total	**0.8**	
Other costs at processing level	*Cost / t/ yr*	
Local taxes	7	2.05
Purchase of product	2640	800
Total cost per ton of product		863
Other cost per operator		
maintenance of processing equipt +oil		212
renewed equipement and bags		200
Building renting		200
Stocking chemicals		300
Capiltal amortization per year		394
Credit costs		300
		US$
Ex-factory price / ton of product		910.0

We assume the price will not change within the project implementation

The two other sections have the same framework. Only the type of labour, type of input and costs change. Some other additional data can be also required. Please refer directly to the tool to see how it looks like.

4.1.8. Climate resilience module:

According to the methodology described in the chapter 3.3.2 on the qualitative multi-criteria analysis of value chain resilience, this module allows to answer the 36 questions corresponding to the 36 qualitative criteria.

These questions that have been considered as relevant to analyse in the qualitative appraisal of the value chain resilience, are divided into 5 sections in the module.

This appraisal is only realized according to how the upgrading project scenario can improve the resilience of households. It does not concern the current situation of the project.

An expert assessment between 0 and 4 is realized, raising the most relevant performance indicators. According to the context of the value chain analysed and the type of project, a weight is addressed to each question. For instance, a project concerning agroforestry do not consider the crop failure as much as a project concerning monocrop banana upgrading.

This module is presented as follows:

Figure 28: Qualitative appraisal of banana value chain resilience within an upgrading scenario

7- Qualitative appraisal of climate resilience induced				
Data entry for qualitative appraisal of climate resilience induced by value chain to be done in light blue cells				
	Buffer capacity of the banana value chain to natural shocks	**Expert group Assessment (0-4)**	*Indicator Weighting (0-3)*	
1	To what extent does upgrading the value chain improve land cover? (e.g. agroforestry, cover crops etc.)	0	3	
2	To what extent does upgrading the value chain reduce soil erosion?	2	3	
3	To what extent does upgrading the value chain improve soil conditions (e.g. soil moisture, soil structure etc.)?	3	3	
4	To what extent does the value chain improve efficient use of water?	0	2	
5	To what extent does upgrading the value chain save water?	0	2	
6	To what extent the value chain area is protected from climate shocks ?	0	2	
7	To what extend the value chain infrastructure - building investments are climate-proof	0	2	
	Sub-Result	**15**	**very low**	34
	Buffer capacity of the banana production	**(0-4)**		
8	To what extent does upgrading the value chain reduce crop failure?	2	2	
9	To what extent does upgrading the value chain improve resistance of banana to pests and diseases?	2	2	
11	To what extent does upgrading the value chain reduce post-harvest losses?	2	2	
12	To what extent does upgrading the value chain increase practice of mixed cropping/intercropping?	0	3	
13	To what extent does upgrading the value chain promote on-farm diversity (annuals/perennials, mixed cropping, mixed farm enterprise e.g. livestock-crop)?	0	3	
14	To what extent does upgrading the value chain reduce yield variability?	0	0	
	Sub-Result	**12**	**low**	24
	Buffer capacity of households in relation to food security	**(0-4)**		
15	To what extent does upgrading the value chain improve household food availability (e.g. through increased household food production or	3	3	
16	To what extent does upgrading the value chain improve household food storage	2	2	
17	To what extent does upgrading the value chain improve household income?	4	3	
18	To what extent does upgrading the value chain increase agricultural production physical assets?	3	2	
19	To what extent does upgrading the value chain improve access of households to agricultural inputs?	1	2	
20	To what extent does upgrading the value chain support (existing or new) farmer groups and networks?	0	2	
21	To what extent does upgrading the value chain increase agricultural skills?	3	2	
22	To what extent does upgrading the value chain improve access of households to climate-related social safety nets (e.g. climate-index	2	2	
	Sub-Result	**43**	**0**	30

	Resilience and self-organisation of households	(0-4)		
23	To what extent does the value chain improve cooperation and networks of farmers (e.g. farmer groups, farmer field schools, farmer	1	1	
24	To what extent does the value chain collaborate with national/sub-national farmer/pastoralist organisations (capacity of farmers/pastoralists	1	1	
25	To what extent does the value chain 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 value chain?	4	2	
27	To what extent does the value chain 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 value chain improve farmer skills to manage groups?	1	2	
29	To what extent does the value chain link agriculture value chains?	4	1	
30	**On-farm reliance: To what extent does the value chain build on local knowledge?**	4	1	
	Sub-Result	28	medium	20
	Market resilience and adaptation capacity to value chain	(0-4)		
31	To what extent does the value chain improve farmer knowledge of threats and opportunities to agricultural production (e.g. climate specific awareness programmes)?	4	2	
32	To what extent does the value chain improve access to extension services?	1	2	
33	To what extent does the value chain improve farmer/pastoralist experimentation (e.g. through farmer/pastoralists field schools, climate field	0	0	
34	To what extent does the value chain improve access to climate information (e.g. seasonal forecasts adapted for agriculture, workshops)?	3	2	
35	To what extent does the value chain improve access to market information?	1	2	
36	To what extent does the value chain improve access to communication networks (e.g. mobile networking, radio programmes)?	0	2	
	Sub-Result	18	low	20
	Total resilience index	116	low	128

4.1.9. EX-ACT B-VC Results: A multi-impact appraisal

As it has been presented in the methodology (Chapter 3), the four main types of indicators are gathered in one module: "Value chain results", in order to be appraised easily and to have a global overview of the environmental and socio-economic performances simultaneously.

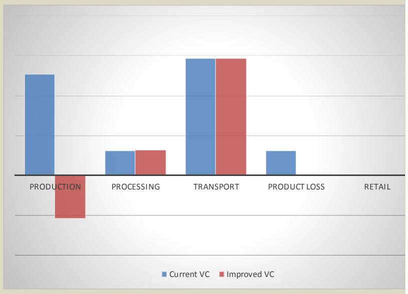
This module is presented as follows:

Project:	Banana organico installacion	Year	2015
Bank:	Agrobanco	Budget (US$)	17236
country	Peru	Households	6
region	0	Hectares	30

Price tCO2 10 US$

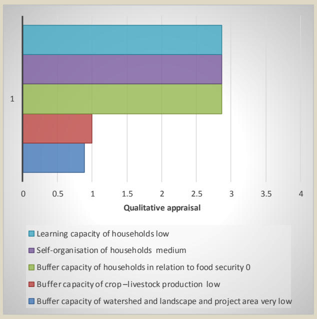
	Climate Mitigation dimension of the value chain (s)	Current situation	Value chain upgrading project	Mitigation impact	
1	GHG impact in tCO2-e per year	190	-186	-376	TCO2/ year
2	GHG impact in tCO2-e per year per hectare	6	-6.20	-13	TCO2/ha
3	Carbon footprint per tonne of production, in tCO2-e per tonne of product	1.3	-0.54	-2	TCO2/ t of product
4	Incremental in tCO2-e [emitted (+) / reduced or avoided (-)]		-38		TCO2
5	Equivalent project cost per tonne of CO2 reduced or avoided, in US$ per tCO2-e		46		US$/TCO2
6	Equivalent value of mitigation impact per year , in US$ /tCO2-e		376		US$/year
7	Equivalent value of mitigation impact per year per ha, in US$ /tCO2-e per year per hectare		125		US$/year / ha

Carbon footprint at the different levels of the Value Chain	Emissions (tCO2/t product) Current VC	Improved VC	Mitigation impact
PRODUCTION	1.268	-0.539	-2
PROCESSING	0.312	0.320	0
TRANSPORT	1.465	1.465	0
PRODUCT LOSS	0.311	0.004	0
RETAIL	0.000	0.000	0
TOTAL	3.356	1.250	-2



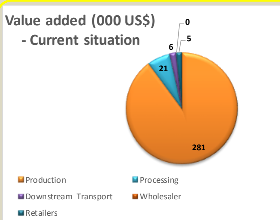
	Climate Resilience dimension (s)	Current situation	Improved VC	
1	Hectares of land managed under climate-resilient practices	0	10	ha
2	Hectares with improved tree and vegetal coverage (land slide, flood resilience)	0	0	ha
3	Number of hectares with increased soil carbon (drought and erosion resilience)		10	ha
4	Number of HH having become more climate resilient		6	HH

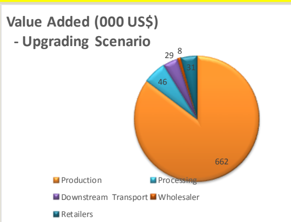
Resilience index of the value chain upgrading	Current situation	Value chain upgrading project
Buffer capacity of watershed and landscape and project area		very low
Buffer capacity of crop –livestock production		low
Buffer capacity of households in relation to food security		0
Self-organisation of households		medium
Learning capacity of households		low
Global climate resilience generated by Value chain		low

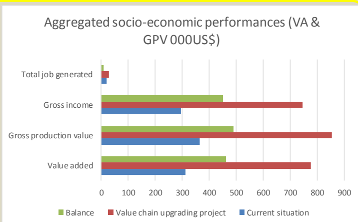


Socio-economic performances of the value chain	Current situation	Value chain upgrading project	Balance	
Production level				
Nb of operator eq	9	12	3	jobs
Gross production Value (GPV)	306	684	378	000 US$
Value Added (VA)	281	662	381	000 US$
Gross Income (GI)	272	650	377	000 US$
VA / tonnes of product	735	774	39	US$
VA / ha	9377	22070	12693	US$
Gross income / farmer - beneficiaries	29745	52181	22436	US$
Packaging				
Nb of operator eq	1	3	1	jobs
Gross processed value	41	92	51	000 US$
Value added	21	46	25	000 US$
Gross income	18	39	22	000 US$
VA / ton of product	55	55	0	US$
Gross income / operator	2932	3025	93	US$
Downstream transportation level				
Nb of operator eq	4	5	1	jobs
Gross production value	8	34	26	000US$
Value added	6	29	24	000 US$
Gross income	3	27	23	000 US$
VA / operator	3930	17559	13630	US$
Gross income / operator	2202	15823	13622	US$
Wholesaler (ripening)				
Nb of operator eq	5	6	1	jobs
Gross production value	5	15	10	000 US$
Value added	0	8	7	000 US$
Gross income	-1	4	6	000 US$
VA / operator	112	3842	3730	US$
Gross income / operator	-629	2172	2801	US$
Retailers				
Nb of operator	1	2	1	Jobs
Gross production value	5	31	26	000 US$
Value added	5	31	26	000 US$
Gross income	3	27	24	000 US$
VA / retailers	490	1330	840	US$
Gross income / retailers	315	1155	840	US$

Aggregated Socio-economic performances	Current situation	Value chain upgrading project	Balance	
Value added	313	776	464	000 US$
Gross production value	365	856	491	000 US$
Gross income	295	747	452	
Total job generated	20	28	8	Jobs created







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