Working document EX-ACT VC case study

Rice Value chain in Madagascar

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EX-ACT VC	:	Ex Ante Carbon Balance Tool for Value Chain
GDP	:	Gross Domestic Product
Ha	:	Hectare
tCO2-e	:	Ton of CO2 equivalent
US$	:	US dollars
Yr	:	year

1. Introduction

This working document present a case study of a multi-impact appraisal of the rice value chain in Madagascar. It allows users to concretely appreciate the functioning of EX-ACT VC, which is a tool derived from EX-ACT but providing a multi-impact appraisal of a food value chain in terms of climate mitigation, climate adaptation and resilience dimension and also providing the socio-economic performances of the food chain analysed.

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 VC. Moreover, it can help users to understand the multi-impact appraisal issued from a specific analysis (although simplified).

This case study allow user to understand how to analysis a complex value chain, involving different type of production, by segmenting it in two sub-value chain. Results are then derived and aggregated, giving a global results for the entire rice chain.

1.2. Data Collection

For this application on EX-ACT adapted for value chain, data have been collected from a global review of the rice chain and the rural poverty in Madagascar, lead during 3 years by M. Bockel from 2005. Mainly used for a global socio-economic analysis, these data have been adapted to fit into the tool. It is assume for this case study that data didn't change (except in terms of prices for the socio-economic analysis) and still represent reality in terms of rice production in Madagascar. However it is a working document and still can be modified.

2. Methodology

2.1. EX-ACT VC

EX-ACT 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 VC tool aims at helping appraising performant and sustainable value chain. The methodology provide both a quantified socio-economic appraisal of value chain both 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 and 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 project. The carbon footprint of the product is calculated for the whole value chain and at the different stage aiming at analysing the environmental performance of the chain. The equivalent economic return is also determined. It could be an important aspect to consider when attempting, for example, to access payments for environmental services.

- **Climate resilience** is assessed using simple quantitative but also qualitative indicators. Adaptation indicators measure the reduction of vulnerability of people, livelihoods and ecosystems to climate change.
- 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.

EX-ACT VC does permit the analysis a value chain from the 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 product.

The current situation of the value chain corresponds to the current production, type of processing and transportation, present in average in the value chain analysed. However, the upgrading scenario use new trends and aims at improving the value chain in terms of climate mitigation, adaptation and socio-economic performance. The multi-impact appraisal provided by EX-ACT VC compare both situation, while the current situation is used as the baseline scenario. The improvement of the value chain can be present in either any level of the chain.

2.2. Analysing an entire value chain

EX-ACT VC had been adapted and retargeted in order to analyze value chain in developing countries. It fits for analyzing either a simple value chain, or a segment of more complex value chain (regional or area specific sub-value chain). 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 aggregate the results. In this case study, rice value chain in Madagascar is segmented in two sub-value chain which are the rainfed rice and the irrigated rice chain. It is important to segment the chain in order to reduce the risks of misunderstanding and uncertainties. Therefore data entry is easier.

3. Context:

3.1. Socio-economic performances of the rice value chain in Madagascar:

With a Monetary Gross Product of 0.8 billion US$ and an economic weight of 1.1 Billion US$, the entire rice supply chain represented the single most important economic activity in Madagascar.

The direct value added in 2000 contributed to 12% of the GDP in current terms and to 43% of agricultural GDP. Therefore, the performance of the rice sub sector determines to a large extent the overall performance of the agricultural sector in Madagascar. A total of 1,721,000 farmers are involved in the production of rice in Madagascar. In addition, there are about 30,000 downstream operators, who perform multiple functions (collection, processing, wholesale, importers, retailers). Since the vast majority of them represent family businesses, there exist approximately 1,750,000 households that are involved in the production, processing and handling of rice. Based on the average family size of 5.7 persons per rural household, it could be calculated that there are about 10 million people in Madagascar, or almost 70% of its application on value chain Case of the rice value chain in Madagascar population, who derive at least part of their economic income from the rice subsector.

3.2. Cultivation of rice

There are four principal types of rice growing, representing 1.81 million hectare in the whole country: irrigated rice, rainfed lowland rice, upland rainfed rice and rice as a first crop after slash and burn (called tavy). In terms of cultivated area, irrigated rice is the most important, covering 82% of all area under rice in 2008. About 60% of irrigated rice is transplanted. Rice is grown in six zones of Madagascar: the north, northwest, and central-western regions; the central part of the Malagasy highlands; the east; and the central-eastern part, including Lake Alaotra, with its swampy areas, plains, and valleys suited for rice.

3.3. Land degradation

Increasing rice production through area expansion in last forty decades (1965-2005) has not prevented the rural population falling deeper into poverty. It has led to widespread deforestation, thereby foregoing income-generating opportunities associated with standing forests. And it has caused massive soil degradation with significant off-site erosion effects severely reducing the production potential of irrigation schemes in the Lac Alaotra, Eastern and Northern Regions. The actual environmental costs associated with a strategy based on area expansion implies that a shift towards a strategy based on systems intensification would potentially generate positive externalities, with corresponding justification for public action to facilitate such shift.

4. Value chain analysis background:

The proposed analysis takes place in the region of “Lac ALAOTRA” in Madagascar and aims at appraising the performance of the rice value chain in terms of climate mitigation, climate adaptation and resilience potential as well as the socio-economic performance induced by the chain. Two situation are analyzed. The first concerns the current situation of the rice chain and is used as the baseline scenario in order to compare the results with the second situation which is an upgrading scenario of the chain.

The upgrading scenario aims at increasing production with higher value, but in particular on translating it to higher income, better climate resilience of watershed, population and rice production, through capacity strengthening in particular in order to improve the standard living of smallholders. From this upgraded production level, it is expected derived improvement for the different stage of the value chain.

The proposed upgrading scenario will be implemented over a period of 10 years and will comprise different component covering major strategic orientations differentiated for both sub-segment of the chain.

The targeted areas concerns: 1,164,000 ha of irrigated rice and 150,000 ha of tavy rice, 156, 000 ha of rainfed rice for the second sub-chain. In general in this region farmers are used to produce the two type of rice with a dominance in irrigated rice. We assume for this analysis that the average area for rainfed rice is 0.8 ha per farmers while the average for the irrigated rice is 1.2 ha per farmers. Therefore 357,500 farmers are involved in the rainfed rice while 970,000 farmers produce irrigated rice. This distinction is important for being able to analyses separately both segment of the value chain.

The project will also promote the adoption of improved agricultural practices in annual crops which should allow for both sub-value chain an increase in yields and a reduction in carbon emissions. Improving annual crops is expected through sustainable intensification and diversification of irrigated and rainfed agricultural systems in the value chain's watersheds. Improved practices will consist mainly in adopting new measures in irrigation and also foster the abandon of the tillage practice. These activities should ensure an increase in productivity in a conservative approach that strengthens the management of natural resources to improve the environment and living conditions. It should generate substantial financial and economic benefits.

Due to the broad land cover of the project, data entered to describe the climate pattern and soil properties, do not take into account the large inter and intra-regional variability of pedo-climatic conditions. The climate is described as Tropical, with a Mean Annual Temperature (MAT) of 22°C and under a *moist* moisture regime. These settings correspond to average temperatures and rainfalls for the country. We chose to describe the area soil type as LAC (Low Activity Clays), the most representative type for the country.

Two different excel file has to be used in order to differentiate the two sub-rice chain. Therefore data concerning pedo-climatic conditions have to be entered twice, and the corresponding module have to be filled for every type of rice analysed in the two excel file. A complete description of the activities for both segment carried out and the corresponding EX-ACT VC analysis is provided below.

5. Irrigated rice segment analysis:

The second segment analysed focus on the irrigated rice, main crop cultivated in Madagascar.

5.1. Background and challenges:

Historically irrigated rice was and stays the main production for small holders in Lac Alaotra, representing 80% of the total area in Madagascar. Agronomic performances of principal rainfed crop are limited because of a random rainfall and duration of the wet season, generally unfertile and fragile soils, often degraded by erosion and pasture, facing a decrease of yield on irrigated rice, of farming income and a degradation of soil fertility. Several physics factors such as a bad water management block growth and productivity of irrigated rice.

5.2. Methodology:

This section provide the different upgraded scenario realized for the rainfed and tavy rice and how to enter data in the different module of EX-ACT VC.

5.2.1. Agricultural production

The current situation of irrigated rice in the region of Lac Aloatra in Madagascar is represented by a high numerous area of rice "aquatique en foule" and low area in improved practices. The upgrading project scenario is built around a rice growth strategy which will allow an increase of the production and considers an increase of improved irrigated rice area. Different changes in terms of practices – water regime and type of organic amendment, are implemented for the upgrading scenario (table below). Moreover, new irrigated area will be implemented for improving productivity and concerning 30 000ha.

	Yield (T/ha)	Area current situation (ha)	Area upgrading scenario (ha)	Water regime in cropping season	Water regime before cropping	Organic amendment type
Irrigated rice direct seeding	1.8	129 000	94 000	Intermittently flooded	Non flooded preseason (<180d)	Straw incorporated shortly before (>30d)
Rice "Aquatic en foule"	2.8	823000	582 000	Continuously flooded	Flooded pre-season (>30d)	Straw incorporated shortly before (>30d)
SRA improved	3.6	189 000	233 000	Continuously flooded	Non flooded preseason (<180d)	Farm yard manure
Intensified SRI	4.3	23 000	175 000	Intermittently flooded	Non flooded pre-season (>180d)	Farm yard manure
Improved direct seeding	2.6	0	80 000	Intermittently flooded	Non flooded pre-season (>180d)	Straw incorporated long before (>30d)

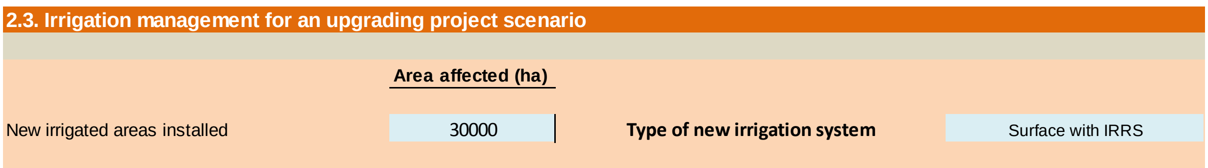
Table 1: Agricultural practices applied on rice in Lac Alaotra

Increase of SRI system which consists in planting single seedlings instead of multiple seedlings in a clump to increase root growth, and not keeping irrigated paddy fields flooded during the rice plants' vegetative growth stage, will allow an important increase of the rice productivity, as well as with the increase of area in improved management.

These data concerns two module: Agricultural practices module and Land Use Change module. The data concerning directly the agricultural module has to be filled in the flooded rice section of the agricultural production because of deep water and irrigated condition at the origin of different CH4 emissions.

Only the irrigation management section of the land use change module has to be filled in as it is shown below.

Figure 1: Irrigation section, Land use change module



5.2.2. Production inputs:

The quantity of input used for the different practices increase within an upgrading scenario thanks to a better access of smallholder in input market (fertilizer and chemical fertilizer). The EX-ACT VC module has to be filled in as shown below.

Figure 2: Production inputs module - section fertilizer consumption

List of specific fertilizers (kg/ha	*Specify NPK parts (%)* N	P	K	Current situation (Kg/ha)	Upgrading project (Kg/ha)
Please enter your specific NPK fertilizer					
Urea	47%			6	43
Lime				0	0
Sewage	5%	N		0	0
Compost	4%	1.5%	1.2%	656	918
NPK	18%	46%	0%	1.7	4.9

5.2.3. Processing

Milling is a crucial step in post-production of rice. The basic objective of a rice milling system is to remove the husk and the bran layers, and produce an edible, white rice kernel that is sufficiently milled and free of impurities.

We assume that 21% of the production is self-processed and consumed locally, not involving local processing facilities. Therefore only 79% of the production is processed. In average and for the whole processing sector we also assume that rice production represents 67% in average for every operator in their processing activity. The energy consumption used by husker represents 5 L/ton of production in average of gasoline. Only jut bags are used for packing the production before transportation to wholesaler.

The only action possible at processing level is a better management of the production to reduce the loss. None modification in inputs/ton of production occurs for the upgrading project scenario. At processing level we assume a reduction from 5 to 3% of production loss and an increase in the processing rate from 66 to 68%.

5.2.4. Transportation

Transportation from farm to retailers only occurs using truck, without any type of conditioning and doesn't change within the upgrading project scenario except for the amount of production wasted at transportation level. We assume a reduction from 3 to 1.5% during the whole transportation process.

Figure 3: Transport Module – Type of transport section

Place of departure	Type of transport	Nb of km
Farm	*Between 1 and 2*	
	Truck in country	35
Processing/storage	*Between 2 and 3*	
	Truck in country	70
Wholesaler		
	Truck in country	70

5.2.5. Socio-economic analysis

Every quantity of input entered in the previous module are set out in this module. Only some additional information concerning the labor force at each level, other costs and operator profile have to be entered. Improvement of agricultural practices, reduction of production loss and improvement of yield means a higher and different repartition of the quantity of labor force per ha and per ton of production. Price and costs have to be taken according to the local market and written in local currency. The data entry for the employment at the different stage of the value chain concerns the number of man per day per hectare (production stage) or per ton of production (downstream stage). An estimation of job equivalent generated corresponding to a full time job employment for the different stage of the production is made using a ratio of 200-250 working days per year. Below is shown how data have to be entered in this module for the input production section of the economic analysis:

Figure 4: Economic analysis module - Section Production

Current situation					Upgraded value chain		
	Quantity (kg or L /ha/an)	Unit	Price : Local currency	Production cost (USD)		Quantity *(kg or L /ha/an)*	Production cost (USD)
Fertilizer			MGF		***Fertilizer***		
Urea	6	kg	4007	8.2	Urea	43	58.7
Lime	0	kg	0	0.0	Lime	0	0.0
Sewage	0	kg	0	0.0	Sewage	0	0.0
Compost	656	kg	150	33.5	Compost	918	46.9
NPK	2	kg	6213	3.6	NPK	5	10.4
Description	0	kg	0	0.0	Description	0	0.0
Description	0	kg	0	0.0	Description	0	0.0
			only prices to enter				
Pesticides					***Pesticides***		
Herbicides	0.4	kg of active ingredient per year	3000	0.5	Herbicides	2.2	2.3
Pesticides	0.0		3000	0.0	Pesticides	0.0	0.0
Fungicides	0.0		3000	0.0	Fungicides	0.0	0.0

5.2.6. Climate resilience analysis.

Concerning the climate resilience induced by an upgrading scenario for this segment of the rice value chain, an assessment on 36 questions corresponding to 5 sub qualitative index have to be answered by the users. The 5 sub-index correspond to: the buffer capacity of watershed, landscape and project area, the buffer capacity of the crop production, the buffer capacity of households in relation to food security but also the self-organization of the households and their learning capacity. For instance one question asked in the last sub-index is: *to what extent does the project improve farmer knowledge of threats and opportunities to agricultural production (e.g. climate specific awareness programmes)?* Users have to appraise a grade between 0 and 4, 0 being no improvement. The appendix 1 give the detailed module and the assessment that have been provided for this case study.

5.3. Irrigated rice results:

5.3.1. Climate mitigation dimension:

The current annual emission of GHG is estimated at more than 21 million TCO2 equivalent per year for this value chain segment. It translates in a carbon footprint corresponding to 18 TCO2 per ton of production. With the implementation of the project, there is still more than 19 million ton of CO2 emitted but the difference between the two situation is at the origin of an important mitigation potential reaching of 1,823,752 TCO2/year or again 1.6 TCO2/ha.

The economic return of this project, assuming that 1 TCO2 cost 10US$, correspond to 16$ per year and per hectare earned while implementing the project. Thus the project benefits to climate mitigation dimension, reducing GHG emission for this segment of the rice value chain. Figure 9 show the different results for the global segment of this value chain in terms of climate mitigation dimension and derived per ha and per ton of product giving thus the carbon footprint of this segment of the value chain.

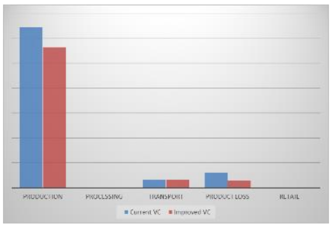
Figure 5: VC results, climate mitigation dimension

Climate Mitigation dimension of the value chain (s)	Current situation	Value chain upgrading project	Balance	
GHG impact per year in TCO2	21,359,649	19,535,752	-1,823,896	TCO2/ year
GHG impact per year per ha	18	16.78	-1.6	TCO2/ha
Carbon footprint per ton of production	6.4	5.65	-0.8	TCO2/ t of product
Incremental Tonnes of CO2 equivalent (t CO2eq) emitted (+) / reduced or avoided (-)		- 182,390		TCO2
Equivalent project cost per Ton of CO2 reduced		10		US$/TCO2
Equivalent value of mitigation impact per year (US$ 10/TCO2)		1,823,896		US$/year
Equivalent value of mitigation impact per year per ha (US$ 10/TCO2)		16		US$/year / ha

A detailed carbon footprint is shown in the figure below, determining the importance of the production stage on the value chain in terms of GHG emissions. Therefore it is important to reduce the emission at this level, and applying climate smart practices allow to reduce the emission at the production level. Moreover, it can be highlighted that the reduction of the production loss as an important impact in terms of mitigation potential.

Figure 6: VC results, detailed carbon footprint

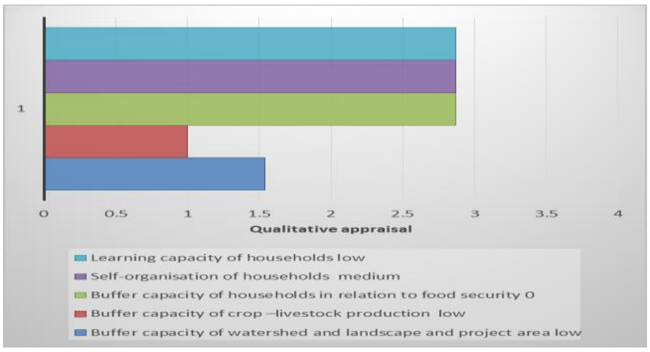
Carbon footprint at the different levels of the Value Chain	Emissions (tCO2/t product) Current VC	Emissions (tCO2/t product) Improved VC	Balance
PRODUCTION	6.442	5.651	-0.791
PROCESSING	0.014	0.014	0.000
TRANSPORT	0.315	0.315	0.000
PRODUCT LOSS	0.618	0.286	-0.332
RETAIL	0.000	0.000	0.000
TOTAL	7.389	6.267	-1.123



5.3.2. Climate resilience dimension

The qualitative appraisal of the climate resilience induced by an upgrading scenario for this segment of the value chain give a medium global climate resilience generated for the chain as shown in the figure below:

Figure 7: Qualitative appraisal of the climate resilience



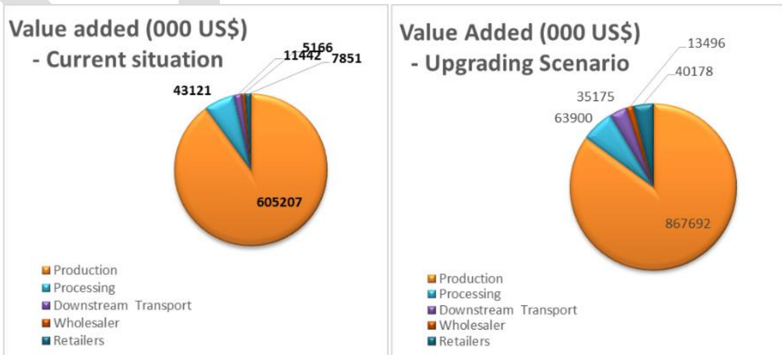
5.3.3. Socio-economic performance of the value chain

Three main socio-economic indicators are calculated for this segment of the irrigated value chain: total job generated, value added and gross income generated for both situation, from the socio-economic module.

In terms of employment, the production of irrigated rice (including transportation, processing and trading) is estimated to generate for the current situation of the value chain 440,951 full time jobs (with an estimation of 200-250 working days per year). The upgrading scenario is at the origin of the creation of 159,574 jobs. Therefore, full time equivalent job with an improvement of the production goes up to 600,525 people working for this segment of the value chain.

In terms of value added, the improvement of this segment of the rice chain involve a global increase in the value added generated at every stage of the value chain. From 672 million US$ generated and distributed on the whole value chain for the current situation in Madagascar, the upgrading scenario allow to increase this amount up to more than 1 billion US$. The figure below show that the distribution of the value added goes mainly to rice producers for both scenario and is widely distributed in terms of gross income to the different operator, representing 63% of the value added for the current situation and 66% for the upgrading scenario.

Figure 8: Detailed value added



Therefore, improving value chain allow to increase the gross income available for every small-holder and operator present and depending on this segment of the chain. The tab below show the value added and the gross income per operator or farmers, per stage of the chain.

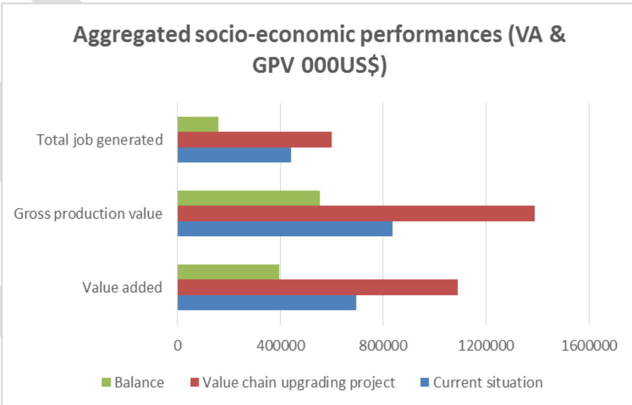
	Value added			Gross income		
	Current situation	Upgrading scenario	Unit	Current situation	Upgrading scenario	Unit
Production	520	745	US$/ha	406	599	US$/ton of rice
Processing / upstream transport	17	25	US$/ton of rice	13,987	20,319	US$/ operator
Downstream transport	20356	38806	US$/ operator	16,943	29,511	US$/ operator
Wholesaler	344,418	899,722	US$/ operator	7,446	178,231	US$/ operator
Retailer	175	455	US$ / retailer	105	455	US$/ retailers

Table 2: Detailed value added and income at the different stage of the value chain

For both indicator and for every steps of the value chain, it appears an increased value added and gross income per operator, ton of rice or hectare depending on the stage of the value chain. The increased productivity by improving the production of the irrigated rice and the reduction of waste allow to increase resource at every level of the value chain for rural and urban population directly depending on the irrigated rice segment.

The next figure summarize the different aggregated results for the four socio-economic indicator on every stage of the value chain as well as the balance between the two situations.

Figure 9: Evolution of the main socio-economic dimension within an upgrading scenario



6. Rainfed rice analysis:

This section explains and describes the entry data for this segment of the rice value chain, only concerning the rainfed and tavy rice practices.

6.1. Background and challenges:

Tavy is a traditional Malagasy farming method to clear forest for farming land. The additionally gained land can be cultivated only for a limited time and the farmers are forced to clear more land. However, where no trees are left, rain cannot sink into the earth. The consequence is erosion, washing the red earth into the rivers and making them "bleed". Although it is raining, the land will slowly dry out. Madagascar has a very rich fauna and flora and many species are endemic, meaning they live and grow only on this island. Due to slash and burn, more and more forests disappear and therefore many species face extinction.

Rainfed rice have traditionally suffered from drought and infertile soils, weeds and plant diseases. Soils there have been badly eroded and degraded as a result of the slash-and-burn agriculture that for many years followed logging. This, in turn, destroys the watershed, producing problems in the lands below.

Already the new upward pressures are resulting in a movement toward permanent agriculture and intensification of land use in upland areas. Those involved find themselves faced—in addition to the usual rainfed problems—with an urgent need to conserve the soil and the diversity of plant species, and to cope with increasingly frequent and severe weed and disease infestations.Those challenges are emerging in the world’s upland rice farming area where already some of the world's poorest farmers try to wrest a living from fragile soils that are fast being degraded. Considering their vulnerability, adaptation and mitigation action plan will be raised by this segment analysis.

6.2. Methodology:

This section provide the different upgraded scenario realized for the rainfed and tavy rice and how to enter data in the different module of EX-ACT VC.

6.2.1. Agricultural production

To produce tavy rice with a small yield of 1T/ha, small holders have to deforest in order to renew the area, with slash-burn practices, corresponding to 1/20 of the existing surface of tavy. Moreover, a deforestation occurs every year reaching 4% of the tavy area during the implementation phase in the region of Lac Alaotra. After several years the lands deforested for implementing annual crop production, are not productive anymore and abandoned, creating degraded land.

Two activities are proposed in this project, in order first to stop any increase of tavy rice practices, and to improve productivity of both crop production, more sustainable.

The project scenario will allow to provide a more stable amount of tavy rice, stopping any increase of slash-burn area, with more sustainable practices under improved condition for better production, limiting deforestation, with improvement of agricultural practices, no till or residues management and manure application. With an upgrading project scenario, no deforestation will occur. At this level a better management of both production will allow a decrease of wasted production from 8% to 4%.

Two module in EX-ACT VC are concerned by those changes: **Module Agricultural production and Land Use Change.**

(i) Land use change:

Figure 10: Land Use change Module

2.1 - Forest land use change for an upgrading project scenario				
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	147037	Final use after deforestation	Annual Crop	YES

2.2 - Non forest Land use change for an upgrading project scenario					
	Area transformed (ha)				
Fill with your description	Current situation	Upgrading project	Initial land use	Final land use	Fire Use?
Reduction of degraded land generated by tavy rice practice	75000	0	Annual Crop	Degraded	NO

For this type of production, the analysis takes places in the annual section of the agricultural production module, because because not generating deep water or irrigated conditions.

(ii) Agricultural practices

Figure 11: Agricultural practices Module

3.1.1 Annual system :											
		Management options			? Definition				*Areas concerned (ha)*		
	Type of crop	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	Grains	?	?	?	?	?	Please select	0		0	
Annual crop staying as annual:											
Riz de montagne trrad	Grains	?	?	?	?	?	Burned	1	150000	0	I
Riz de montagne amél	Grains	Yes	?	Yes	?	Yes	Please select	1.5		150000	I
Riz pluvial trad	Grains	?	?	?	?	?	Please select	1.3	136000		I
Riz pluvial amél	Grains	Yes	?	Yes	?	Yes	Please select	1.5		136000	I
description 5	Default	?	?	?	?	?	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	**286000**	**286000**	

6.2.2. Agricultural input:

The quantity of input used for both traditional practices are low due to a low level of mechanization and access to input. The project aims to improve productivity by providing better access to fertilizer.

Figure 128: Production input Module

List of specific fertilizers (kg/ha	*Specify NPK parts (%)* N	P	K	Current situation (Kg/ha)	Upgrading project (Kg/ha)
Please enter your specific NPK fertilizer					
Urea	47%			2	10
Lime				0	0
Sewage	5%	N		0	0
Compost	4%	1.5%	1.2%	661	1000

6.2.3. Processing and transportation:

Concerning processing and transportation, data entered remain the same than for the rainfed rice segment. Even though rainfed rice area are more difficult to access, the average remain the same.

6.2.4. Socio-economic analysis

Every quantity of input entered in the previous module are set out in this module. Only some additional information concerning the labor force at each level, other costs and operator profile have to be entered. Improvement of agricultural practices, reduction of production loss and improvement of yield means a higher and different repartition of the quantity of labor force per ha and per ton of production. Price and costs have to be taken according to the local market and written in local currency. The figure 11 show below the data entry for labor force. From the current situation to the upgraded scenario, the number of man per day increase per hectare, while the salary remain the same for both situation and for every type of tasks needed to grow rice.

Figure 139: Economic analysis - Section production - Item Labour force

Current situation					Upgraded value chain		
***Labor per ha* (man-days)**	*enter also labour*				***Labor per ha***		
Land preparation-tillage	10	*MD/ha*	5866	20.0	Land preparation-tillage	5	10.0
Seeding- input procurement	10		5866	20.0	Seeding- input procurement	8	16.0
Weeding - treatment	15		5866	30.0	Weeding - treatment	20	40.0
Manure- compost delivery	10		5866	20.0	Manure- compost delivery	20	40.0
Harvesting- farm transport	8		5866	16.0	Harvesting- farm transport	10	20.0
Other tasks	8		5866	16.0	Other tasks	10	20.0
Total	61				Total	73	

6.3. Rainfed rice results:

6.3.1. Climate mitigation dimension:

The current annual emission of GHG is estimated at more than 3 million TCO2 equivalent per year for this value chain segment. It translates in a carbon footprint corresponding to 9.8 TCO2 per ton of production. With the implementation of the project, GHG are sequestered in the soil, created a sink of 206 590 TCO2/year. The mitigation potential induced by this implementation is up to 3 million TCO2 per year.

The economic return of this project, assuming that 1 TCO2 cost 10US$, correspond to 67$ per year and per hectare. Thus the project benefits to climate mitigation dimension, reducing GHG emission for the whole value chain. Figure 9 show the different results for the global segment of this value chain in terms of climate mitigation dimension and derived per ha and per ton of product giving thus the carbon footprint of this segment of the value chain.

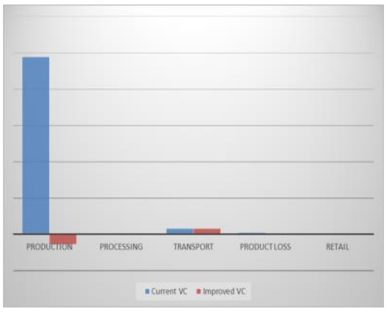
Figure 14: Climate mitigation dimension of the rainfed rice segment

Climate Mitigation dimension of the value chain (s)	Current situation	Value chain upgrading project	Balance	
GHG impact per year in TCO2	3,197,722	- 206,590	-3,404,312	TCO2/ year
GHG impact per year per ha	6	-0.41	-6.7	TCO2/ha
Carbon footprint per ton of production	9.8	-0.55	-10.3	TCO2/ t of product
Incremental Tonnes of CO2 equivalent (t CO2eq) emitted (+) / reduced or avoided (-)		- 3,404,312		TCO2
Equivalent project cost per Ton of CO2 reduced		0		US$/TCO2
Equivalent value of mitigation impact per year (US$ 10/TCO2)		34,043,120		US$/year
Equivalent value of mitigation impact per year per ha (US$ 10/TCO2)		67		US$/year / ha

The most important source of GHG emission at the different level of the value chain comes from the production, as you can see below. This analysis show that the improvement of the rice value chain is crucial in terms of mitigation potential.

Figure 15: Carbon footprint at the different level of the value chain

Carbon footprint at the different levels of the Value Chain	Emissions (tCO2/t product) Current VC	Improved VC	Balance
PRODUCTION	9.785	-0.547	-10.332
PROCESSING	0.014	0.014	0.000
TRANSPORT	0.315	0.315	0.000
PRODUCT LOSS	0.095	0.003	-0.092
RETAIL	0.000	0.000	0.000
TOTAL	10.209	-0.215	-10.424



6.3.2. Climate resilience dimension

In terms of climate resilience dimension, the project is at the origin of 150 000 ha with an increase of soil carbon benefiting to 114 000 farmers / households. The economic analysis allow to analyse more precisely how this upgraded value chain benefit to those smallholders. The qualitative appraisal remain approximately the same and the global resilience induce by the value chain is medium.

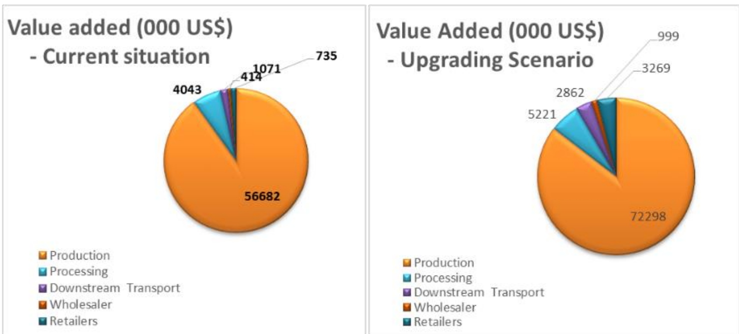
6.3.3. Socio-economic performance of the value chain

Three main socio-economic indicators are calculated for this segment of the rainfed value chain: total job generated, value added and gross income generated for both situation, from the socio-economic module.

In terms of employment, the production of rainfed rice (including transportation, processing and trading) is estimated to generate for the current situation of the value chain 71,398 full time jobs (with an estimation of 200-250 working days per year). The upgrading scenario is at the origin of the creation of 14,378 jobs. Therefore, full time equivalent job with an improvement of the production goes up to 85,777 people working for this segment of the value chain.

In terms of value added, the improvement of this segment of the rice chain involve a global increase in the value added generated at every stage of the value chain. From 62 million US$ generated and distributed on the whole value chain for the current situation in Madagascar, the upgrading scenario allow to increase this amount up to more than 84 million US$. The figure below show that the distribution of the value added goes mainly to rice producers for both scenario and is widely distributed in terms of gross income to the different operator,

Figure 16: Value added distribution by type of economic operator irrigated rice for both situation



representing 41% of the value added for the current situation and 47% for the upgrading scenario.

Therefore, improving value chain allow to increase the gross income available for every small-holder and operator present and depending on this segment of the chain. The tab below show the value added and the gross income per operator or farmers, per stage of the chain.

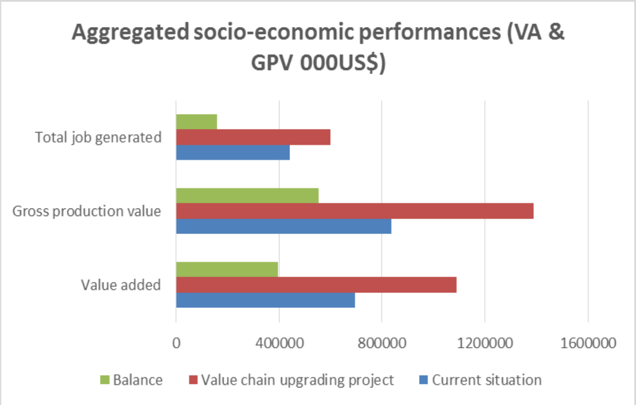
Table 3: Detailed socio-economic indicator by stage of the value chain for both situation – rainfed rice segment

	Value added			Gross income		
	Current situation	Upgrading scenario	Unit	Current situation	Upgrading scenario	Unit
Production	198	253	US$/ha	61	85	US$/ton of rice
Processing / upstream transport	17	25	US$/ton of rice	23,647	24,480	US$/ operator
Downstream transport	20356	38806	US$/ operator	18,675	36,672	US$/ operator
Wholesaler	27,589	66,599	US$/ operator	9,843	40,470	US$/ operator
Retailer	175	525	US$ / retailer	105	455	US$/ retailers

For both indicator and for every steps of the value chain, it appears an increased value added and gross income per operator, ton of rice or hectare depending on the stage of the value chain. The increased productivity by improving the production of the irrigated rice and the reduction of waste allow to increase resource at every level of the value chain for rural and urban population directly depending on the irrigated rice segment.

The next figure summarize the different aggregated results for the four socio-economic indicator on every stage of the value chain as well as the balance between the two situations.

Figure 1710: Aggregated socio-economic results for irrigated rice segment



7. Aggregation of both segment – Results:

After having analyzing both segment of rice value chain present in Lac Alaotra in Madagascar, results can be aggregated to analyze the whole value chain, in terms of mitigation, adaptation, resilience and socio-economic performance. An important increase in terms of productivity is provided by the implementation of an upgrading scenario for both segment. The first tab summarize the total area cultivated and the production for both segment of the rice value chain.

Table 4: Aggregated production for the global rice sector

	Total area cultivated	Total production – curent situation	Total production – upgrading scenario
Irrigated rice	1,164,000 ha	3,234,058 ton	5,062,003 ton
Rainfed rice	286,000 ha	302,588 ton	411,840 ton
Total	1,450,000 ha	3,536,646 ton	5,473,843 ton

The improvement of both rice agricultural practices allow to increase significantly the quantity of the production. From 3 million tons produced, the rice chain goes up to more than 5 million tons. This increase in the productivity has repercussion in terms of socio-economic performance for the whole value chain. The following results are estimated by aggregating the results of the two analysis made for the differentiated segment of the chain.

The tab represents the different indicators calculated for the whole value chain, and it can be highlighted a major improvement in term of climate mitigation dimension, carbon footprint and socio-economic performance induce by the upgrading scenario on both segment of the rice value chain.

Table 5: Aggregated results for the global rice value chain

Indicator	Current situation	Upgrading situation	Balance	Unit
Climate mitigation dimension (addition)				
GHG impact / yr	24,555,371	19,329,162	-5,226,209	TCO2/yr
GHG impact / yr / ha	24	16.3	-7.6	TCO2/yr/ha
Carbon footprint (average) TCO2/ton of product				
Production	8.1	2.5	-5.5	
Processing	0.0.14	0.014	0	
Transport	0.315	0.315	0	
Production loss	0.3565	0.14	-0.21	
Aggregated socio-economic performances				
Value added	735,730	1,109,411	+373,681	000US$
Gross production value	913 910	1 503 115	+589,205	000US$
Gross income	451,740	726,861	+27,5121	000 US$
Total job generated	512 349	686 302	+173 953	Job created

Improving agricultural production and reducing wasted production at every level of the chain has an important climate mitigation impact, by reducing the carbon emission of more than 5 millions tCO_2-e per year. This reduction is mainly induced at the production level by the improvement of both segment of the value chain involving an important reduction of the carbon footprint at this stage.

173 953 jobs have been created within the upgrading scenario, giving resources either for rural and for urban population working on the different stage of the value chain. In terms of value added generated for the global value chain in the region of Lac Alaotra in Madagascar, the improvement of the two segment involve a global increase in the value added generated at every stage of the value chain. From 735 million US$ generated and distributed on the whole value chain for the current situation in Madagascar, the upgrading scenario allow to increase this amount up to more than 1bilion US$. Considering the results for both value chain, it is obvious that the value-added in the rice value chain goes mainly and directly to rice producers in the form of income of agricultural workers and point the direction that the benefits of any rice productivity increase most likely would be widely distributed and would directly support the bottom-line of many rural households. It is highlighted in the tab above by the important increase of the global gross income generated.

For a more precise analysis, the tabs below summarize the balance of value added and gross income per operator, farmer or per hectare generated within an upgrading scenario. By assuming that one producer has in average 0.8 ha of rainfed rice and 1.2 ha of irrigated rice, we can weigh the value added and the gross income generated for the whole value chain. The tab below summarize at a micro level the improvement in terms of value added and gross income for the entire value chain.

Table 6: Detailed socio-economic indicator by stage of the global rice chain

	Value added			Gross income		
	Current situation	Upgrading scenario	Unit	Current situation	Upgrading scenario	Unit
Production	782	1096	US$/ha	536	786	US$/ton of rice
Processing / upstream transport	34	50	US$/ton of rice	37,634	44,799	US$/ operator
Downstream transport	40,712	77,612	US$/ operator	35,618	66,183	US$/ operator
Wholesaler	372,007	966,321	US$/ operator	17,289	218,701	US$/ operator
Retailer	350	980	US$ / retailer	210	910	US$/ retailers

Therefore in a strategy aimed at setting the stage for more inclusive economic growth as mean to reduce poverty, it appears that efforts aimed at increasing rice productivity by implementing new sustainable strategies would potentially have a high impact in strengthening the link between poverty reduction and economic growth in Madagascar. Moreover, a multiplying effect of the potential distribution of the benefits associated with productivity growth and resilience of the population in the rice sector may suggest that it will benefit for unlocking additional growth.

Appendix

#	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	1	
2	To what extent does the project reduce soil erosion?	2	2	
3	To what extent does the project improve soil conditions (e.g. soil moisture, soil structure etc.)?	2	2	
4	To what extent does the project improve efficient use of water?	3	2	
5	To what extent does the project save water?	3	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	**20**	**low**	26
	Buffer capacity of crop –livestock production	**(0-4)**		
8	To what extent does the project reduce crop failure?	2	2	
9	To what extent does the project improve resistance of crops to pests and diseases?	2	2	
10	To what extent does the project improve resistance of livestock to pests and diseases? (e.g. through	0	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 (crop/livestock) 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 the project improve household food availability (e.g. through increased household	3	3	
16	To what extent does the project improve household food storage	2	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?	3	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	**43**	**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	**121**	**medium**	120