Annex 3

Economic and Financial analysis

PREFOREST CONGO - Project to reduce greenhouse gas emissions from forests in five departments in the Republic of Congo

Economic and Financial analysis

Introduction

An economic and financial analysis (EFA) of the project was undertaken in order to assess the economic soundness of the project and the likely impact of project interventions. More specifically, the economic and financial analysis intends to quantify the net incremental financial and economic benefits generated by the investments.

The financial analysis takes into account the estimated benefits from the point of view of individual agroforestry farms and beneficiaries, while the economic analysis takes into account the estimated incremental benefits and costs of the project investment to society as a whole.

Project areas, project beneficiaries and benefits

The project intends to reduce greenhouse gas (GHG) emissions and to increase the resilience of the target group in the South of the country by focusing activities in three main basins of supply for food, wood and charcoal. These consist in the fuelwood supply basin of Brazzaville, Pointe-Noire and Road 1, which connects the cities of Loudima, Madingou and Nkayi. More specifically, the intervention area covers 13 districts in the departments of Plateaux, Kouilou, Niari, Pool and Buenza.

Under the first component the Project will implement preparatory activities to facilitate access to land and to secure property rights for land. Under the first component the project will also develop a participatory mapping that will be also used to establish the locations of agroforestry systems. Under the second component the Project will support the establishment of agroforestry systems. Under the third component the project will strengthen the national agricultural financing system and business capacities.

The first and the third component have no direct quantifiable economic benefits. However, the first component is essential to reduce reforestation, and to identify the areas for the implementation of Component 2 activities and for the extraction of wood for charcoal production envisaged in Component 2. Consequently, all project costs are included in the economic analysis (including costs for component 1), as well as the project management component. Component 2 have direct quantifiable economic benefits. The target group will consist of groups smallholders and, landowners. Companies establishing agroforestry systems will also be considered. Finally, under Component 3 the Project intends to strengthen access to rural credit by beneficiaries and by developing business capacities and by tackling the main barriers faced by farmers in accessing micro-finance from both the demand and supply sides.

The main benefits of the project are the following:

Reduction of greenhouse gas (GHG) emissions from land use changes. The project is expected to improve carbon sequestration by reducing deforestation and establishing agroforestry systems. More specifically, the results of the analysis conducted by using the FAO Ex-Act tool for GHG emissions calculations shows that the establishment of agroforestry systems and the reduction of deforestation are expected to reduce the emissions of GHG by 0.84 million tCO2eq annually.

Improved resilience. The agroforestry system that the Project intends to promote is expected to improve resilience. Planting trees to produce wood fuel represents an additional source of income in case of harvest losses of annual crops due to climate extreme events. The diversification of income sources promoted by funding fruit trees and perennial tree crops also improves resilience to climate extreme events.

Additional income. The envisaged additional income generated by funding agroforestry systems is expected to increase incomes and profits for landowners and for the small farmers that will establish the proposed agroforestry systems. The quantification of the benefits is reported below in the financial analysis.

Methodology and assumptions

Incremental analysis. Incremental costs and benefits analysis was performed by comparing "with" and a "without" project scenario performances. The without project scenario (WOP) was formulated based on the existing actual cropping pattern, crop productivities, cropping intensities, input prices, and output prices observed in the project areas. The with-project situation (WIP) reflects likely changes in the planned cropping patterns and yields following the project interventions.

A cash flow model was used to conduct an ex-ante analysis of the project investment. Annual cash flows were estimated as the difference between without-project and with-project net benefits for direct beneficiaries.

The financial analysis shows that provision of non-reimbursable grants is needed to establish agroforestry systems (see below). This is expected to result in additional areas planted with agroforestry systems or fruit orchards and in the reduction of forest areas cleared by slash and burn practices. So the foregone agricultural production is expected to be minimal. This EFA uses a conservative approach by assuming that for every hectare planted by the project, beneficiaries would forego the production of 0.25 hectares[1] of the traditional farming system, which is based on maize, cassava and groundnut intercropped. The production of maize, cassava and groundnut is the opportunity cost of the proposed agro-forestry systems for the without project scenario.

Parameters. The cost-benefit analysis is based on crop and farm-level assumptions on yields, input requirements, prices and costs in constant 2019 currency amounts for the WIP and WOP scenarios. The parameters for the models are based on information gathered during the project design, including interviews with farmers and entrepreneurs, information provided by the feasibility studies and some project design team's estimates. Price information gathered includes in particular costs of labor, capital costs (equipment, tools), inputs, and outputs. Conservative assumptions were made both for inputs and outputs, taking account possible risks.

Quantified benefits. Quantified benefits captured in the economic and financial analysis are the incremental net benefits of agroforestry systems. More precisely, the project will establish 14,500 hectares of agroforestry systems, of which 11,800 hectares are funded by the GCF and 2,700 hectares are funded by FAO (CAFI).

Discount rate. For the calculation of the net present value (NPV) of the financial analysis a discount rate of 10% was used. The interest rate for a 10 -year government bond is 6%. This figure was increased to 10% to reflect the risk of the agricultural activity.

For the economic analysis, the choice of the discount rate was based on a different approach. Historically, sustained real per capita growth rates, ranging from 0 to 5% per year, have been most commonly observed around the world. Narrowing this to today's World Bank client countries for lower middle income countries (like Congo) growth averaged 2.8%-2.9% over the last twenty years. Rounding these numbers to 3%, the discount rate for the economic analysis was obtained by

[1] 0.25 hectare is the typical extension of cultivated parcels by small farmers in Congo

multiplying this figure by an elasticity of marginal utility of consumption of two[2]. The resulting social discount rate is 6%, which is also the discount rate recommended by the World Bank for the economic analysis of projects[3].

Impact of climate events. The main climate change related stressors to forestry comprise generalized temperature and water stress recurrence and extreme events (i.e. floods). The effects of these stressors were taken into account for the selection of the practices proposed by the project on forestry and agroforestry investment, with their consequences on the composition of the related costs. Unfortunately, available literature for Congo does not make it possible to predict the frequency of occurrence of extreme events or decline in yields. So, instead of guessing the impact of climate-related stressors, this economic and financial analysis (EFA) only value externalities caused by a reduction of GHG emissions (which are quantified) but it does not account for the effect of climate related events on forestry and agriculture. This choice is more conservative than modelling the effect of extreme events, since accounting for climate stressors involves a reduction of the net benefits of the without project scenario, and consequently a reduction of the opportunity cost of the project.

Time-horizon. The analysis is based on a 25-year period, during which the Project will generate benefits, and includes an eight-year project implementation period. There are no further investment costs after eight years of project implementation. However, annual operation costs were included in the economic analysis until Year 25, as these costs will have to be incurred if the future benefits of the Project are to be sustained. The sensitivity analysis also includes the results of a more conservative 20-year time horizon (including the Project implementation period).

Prices. The financial analysis was conducted at farm level by using the market prices collected during the field missions occurred in the first semester of 2019, when the exchange rate was 580 FCFA per $US. For the economic analysis market prices were converted to shadow prices. A world price numeraire approach was used[4]. The economic analysis ignores all transfer payments such as taxes and subsidies paid to or received from farmers. Conversion factors (CF) were calculated by using border parity prices. They vary between 0.82 to 1.1 , with a standard CF of 0.88. A list of prices and conversion factor used in the economic and financial analysis is available in the "Prices & assumps" spreadsheet of the EFA document (attached in Appendix 1 of this annex).

Valuation of GHG emissions avoided. Coherently with the suggestions of the GCF for pilot programs for REDD+ Results-based Payment, the economic analysis assumed a price of $US5 per tCO2eq. No other valuation of ecosystem services or externalities (e.g. biodiversity improvement, reduction of soil erosion) was accounted for.

Financial analysis

The main purpose of the financial analysis is to examine the viability of the main crops, agroforestry systems and entrepreneurial activities that will be supported by the project from a private point of view and to assess their potential increase in profitability as a result of project interventions. In the financial analysis all costs and benefits are valued at market price.

Agroforestry systems

For the agroforestry systems four models are here envisaged. The main characteristics of each model are reported below (a detailed description is included in the feasibility studies). The first two models are two possible variants of the Mampu

[2] Economists typically assume that if a beneficiary is x% richer, the marginal value of an additional dollar of benefits is lower by between x% and 2x% (so the elasticity of marginal utility of consumption is estimated to be between 1 and 2).
[3] World Bank (2016) *Discounting Costs and Benefits in Economic Analysis of World Bank Projects*. Washington DC
[4] See Curry, S and Weiss, J (1993) *Project analysis in Developing Countries*, Palgrave for a description of a word price and domestic price approach.

system (from the name of the village in DRC where it is widely adopted), which is an agroforestry system commonly used on the Baketé Plateu in DRC. These first two models consist in a rotational woodlot and consequently envisage an expansion in time of the cultivated areas, while the others not.

A. Acacia - maize - cassava. It consists in a rotation over seven years, whereby each year is planted one additional parcel of acacia, maize and cassava. The second year one additional parcel is planted as in the first year. The parcel that was planted during the first year is not planted again, while acacia trees keep growing. At the end of the rotation (in Year 7) the parcel that was planted during the first year is planted again so that a new rotation starts. The outputs of this model are maize (planted and harvested every year), cassava (planted every year and harvested after 15-18 months) and charcoal (produced every year from Year 7).

B. Acacia - maize - groundnut. This a variant of the Mampu system. With respect to the previous model the difference is that maize is substituted by groundnut.

C. Cacao - plantain - groundnut - safou. In this model during the first year plantain and groundnut are planted. The following year cacao seedlings are planted in the same parcel (that is, when plantain plants are big enough to provide shadow to plant seedlings). Cacao trees are mixed with safou (African plum), which provides a high valuable fruit (with a high oil content) widely consumed in Congo in addition to shadow for cocoa trees.

D. Avocado - okra -aubergine. In this model vegetables (okra and aubergine) are planted along with avocado seedlings. Vegetables are replanted each year until the avocado trees overshadow vegetable production. So each year, the number of planting beds for vegetable production is assumed to reduce until Year 6 (which is the last year when vegetables are produced).

E. Orange - maize- groundnut - pigeon pea - cassava. In this model annual crops are planted along with orange seedlings. In this first year groundnut and maize are intercropped and along with orange seedlings. Given the short duration of maize and groundnut production cycles, the two crops are planted twice in the same year (in the project areas there are two rainy seasons per year, one starting in October and one in March-April). In Year 2 pigeon pea (i.e. a leguminous crop fixing nitrogen in the soil) is planted once. During the third year cassava is planted. After cassava harvest the parcel is left nine months' fallow. In Year 5 the rotation starts again for a new cycle that is repeated once only, until orange trees overshadow annual crop production.

The profitability of each model from the farmer' point of view is include in Table 1

Table 1: Financial performance (in $US) of proposed models for 1 Ha

	Initial investment for 1 Ha	Incremental net benefit			20 year horizon		25 year horizon	
		Yr 1 without grant	Yr 1 with grant	Yr 10	NPV without grant	NPV with grant	NPV without grant	NPV with grant
Mampu 1 (Acacia - maize - cassava)	1,057	-420	395	21	-860	1,635	-819	1,676
Mampu 2 (Acacia - groundnut - cassava)a	1,192	-345	574	114	-175	2,579	-111	2,643
Cacao - plantain - safou - groundnut	4,028	-100	1,518	987	2,503	5,299	3,379	6,175
Avocado - okra - aubergine	3,778	1,062	3,975	2,660	17,790	20,438	19,459	22,107
Orange -maize - groundnut - pigeon pea - cassava	2,973	1,181	3,473	173	4,010	6,093	4,107	6,191

Although the two Mampu models present a positive NPV once part of the investment cost is covered by the project, they have a relatively low outlook in comparison with the other models. The profitability of the cocoa, orange and avocado based models is much higher. The lower financial performance of the two Mampu models is common for forestry activities, which generate public good benefits. Also, the models where developed on very conservative assumptions, that is, all agricultural operations are paid at market price, while there is a certain probability that some operations are conducted by unpaid family labor or that sharecropping mechanisms are developed between charcoal producers and Acacia tree owners.

Overall, the table shows the Mampu system are not financially viable without a grant covering part of the investment costs. The project will cover 80% of the first year cost for smallholders and private citizens, 100% for indigenous groups and 50% for companies. The weighted expected average of the grant has been used in the financial analysis (and reflected in the project budget as a cost). With this grant the NPV becomes positive for the two Mampu systems.

Table 2 shows the needed relative price increase of charcoal to make the two Mampu system models viable without a non-refundable grant. The table shows that for the Acacia/cassava/groundnut a 5% increase of the price of charcoal makes the NPV positive. For the Acacia/cassava/maize model the increase in the price of charcoal needed to make the NPV positive is 22% (over a 20-year time horizon). It is expected that price of charcoal will increase during the coming years as a consequence of reduced deforestation practices which would lower supply of other fuelwood and due to increased demand in urban centers. In this way, the Mampu systems become viable and replicable even without non-refundable grants.

Table 2: Increase in charcoal price needed to make the NPV positive in the Mampu systems (without grants)

	Over 20-year time horizon	Over 25-year time horizon
Mampu 1: Acacia - maize - cassava	22%	18%
Mampu 2: Acacia - groundnut - cassava	5%	3%

Even though the NPV is positive for the other models without grant, the use of grant is still important. Currently smallholders are not bankable. Moreover, agricultural loans are extremely rare in the Rep. of the Congo. The investment costs are high for all models. So, without a grant no investments in agroforestry will take place. The use of non-reimbursable grants to cover part of the investment cost is also intended to reduce risks and possibly to motivate financial institutions to provide loans to cover the part of the investment cost that is not covered by the project. It is also expected that the activities conducted by the project under component 3 will relax access to credit constraints, thus facilitating replicability.

Overall, the NPV is higher in the avocado-based system. This is because this model also envisages the production of vegetables, which are high value products.

Changes that make the NPV negative are included Table 3. The table shows that that the two Mampu systems have relatively low switching values, while the other much higher.

The five agroforestry models are here include as a reference. The project is demand-driven, meaning that the project will fund agroforestry models that will be requested by beneficiaries, provided that they are financially sustainable (once the grant covering part of the investment costs have been paid). Variations of the proposed models will be accepted. A financial analysis will be conducted for business plans submitted and in case the switching values are too low (as for Mampu 1) they will not be funded.

Table 3: Switching values (over a 25-year scenario)

	Over 20 years		Over 25 years	
	Revenues reduced by	Costs increased by	Revenues reduced by	Costs increased by
Mampu 1: Acacia - maize - cassava	10.8%	12.0%	10.1%	11.2%
Mampu 2: Acacia - groundnut - cassava	15.3%	18.1%	14.4%	16.8%
Cacao - plantain - safou - groundnut	78.6%	365.7%	80.0%	397.6%
Avocado - okra - aubergine	49.2%	96.7%	49.5%	97.7%
Orange -maize - groundnut - pigeon pea - cassava	39.9%	66.4%	38.6%	62.9%

Economic analysis

The purpose of the economic analysis is to assess a project's worthiness from a society's perspective. Costs and benefits are valued at shadow prices. The incremental net benefits of each activity are aggregated by the number of hectares or beneficiaries that a project targets.

For agroforestry systems funded by the GCF (11,800 hectares) it is assumed that 70% of the total target area will be Mampu systems, 16% cacao-based systems, 7% avocado-vegetable systems and 7% orange-based systems. The agroforestry systems planted by FAO (CAFI) (2,700 hectares) will be based on the Mampu system.

Table 4 presents the aggregated results of economic analysis for the internal rate of return (EIRR) and the net present value (ENPV). The results are presented with and without accounting for GHG emissions saved. With a time-horizon of 25 years, even without accounting for GHG emissions avoided, the ENPV is positive (26.6 million USD) and the EIRR (14.0%), which is higher than then social discount rate. The ENPV remains positive (15.5 million USD) and the EIRR higher than the social discount rate even with a time horizon of 20 years. . With a 25-year time horizon, by accounting for the avoided GHG emissions the ENPV becomes 76.3 million USD and the EIRR 63.4%. Even with a 20-year time horizon the economic outlook remains good when GHG emissions saved.

Table 4: Results of the economic analysis

	Without GHG emissions accounting		With GHG emissions accounting	
	20-yr horizon	25-yr horizon	20-yr horizon	25-yr horizon
ENPV (million USD)	15.0	26.6	59.1	76.3
EIRR	12.1%	14.0%	63.4%	63.4%

A sensitivity analysis was carried out by introducing variations in cost increases, in yields, delays in the accruals of benefits, reductions of benefits and changes on planned planted areas. The results are included in Table 5, which shows that the project is not sensitive to reasonable increases in costs and decrease in benefits.

With a 20-year time horizon, and with no valuation of GHG emissions reductions, the scenarios that would make the ENPV negative consists in planting only Mampu systems over the total target area of 14,500 hectares (with no planting of fruit orchards or cocoa-based system), a reduction of benefits by 30% or benefits delayed by three years. Indeed, the financial analysis shows that the Mampu system is less profitable than the other considered agroforestry systems. However, when the reduction of GHGs emission is taken into account, also a scenario whereby all planted areas consist in Mampu systems yields a positive ENPV for both time horizons.

Table 5: Sensitivity analysis (without accounting for GHG emissions)

	No GHG emissions accounting		With GHG emissions accounting	
	20-year horizon	25-year horizon	20-year horizon	25-year horizon

	NPV (million USD)	EIRR	NPV (million USD)	EIRR	NPV (million USD)	EIRR	NPV (million USD)	EIRR
Benefits reduced by 10%	10.86	10.6%	21.33	12.6%	50.58	47.5%	66.00	47.7%
Benefits reduced by 20%	6.75	9.0%	16.03	11.2%	42.06	36.6%	55.74	37.0%
Benefits reduced by 30%	2.65	7.2%	10.73	9.7%	33.54	28.5%	45.47	29.2%
Benefits delayed by 1 year	10.14	10.0%	21.78	12.3%	47.02	26.5%	64.17	27.2%
Benefits delayed by 2 year	5.45	8.2%	17.06	10.8%	39.01	21.2%	56.12	22.2%
Benefits delayed by 3 year	1.06	6.4%	12.61	9.5%	31.49	17.5%	48.54	18.9%
Costs increased by 10%	12.36	10.7%	23.99	12.8%	56.49	48.7%	73.63	48.9%
Costs increased by 20%	5.64	8.1%	16.05	10.5%	45.36	32.3%	60.73	32.8%
Costs increased by 30%	-1.08	5.6%	8.11	8.2%	34.23	22.9%	47.82	23.9%
Forest seedlings puchased at market prices (not self produced)	7.03	8.6%	18.69	11.0%	59.10	63.4%	76.26	63.4%
Increase in price of purchased inputs by 10%	13.33	11.5%	24.62	13.4%	57.46	61.7%	74.26	61.8%
Increase in price of purchased inputs by 20%	11.69	10.8%	22.62	12.9%	55.82	60.0%	72.25	60.1%
Increase in price of purchased inputs by 30%	10.05	10.2%	20.61	12.3%	54.18	58.3%	70.25	58.4%
Increase in cost of agricultural operations by 10%	10.24	10.2%	21.08	12.3%	54.37	56.3%	70.71	56.3%
Increase in cost of agricultural operations by 20%	5.51	8.3%	15.53	10.7%	49.64	49.5%	65.16	49.7%
Increase in cost of agricultural operations by 30%	0.78	6.3%	9.98	9.0%	44.91	43.4%	59.61	43.6%
Increase in price of purchased inputs and agricultural operations by 10%	8.60	9.5%	19.07	11.8%	52.73	54.6%	68.71	54.7%
Increase in price of purchased inputs and agricultural operations by 20%	2.23	6.9%	11.52	9.5%	46.36	46.4%	61.15	46.6%
Increase in price of purchased inputs and agricultural operations by 30%	-4.14	4.2%	3.96	7.2%	39.99	39.1%	53.60	39.4%
Reduction in planted area uniformly by 15%	9.03	9.9%	18.96	12.0%	53.16	59.4%	68.60	59.5%
Reduction in planted area uniformly by 30%	3.10	7.4%	11.30	9.8%	47.23	55.3%	60.93	55.3%
Reduction in planted area uniformly by 50%	-4.82	3.5%	1.07	6.4%	39.31	49.5%	50.71	49.6%
No planting of fruit orchards (total area planted 12,800 Ha)	-12.35	0.2%	-6.04	4.0%	31.78	33.7%	43.60	34.2%
Planting only Mampu agro-forestry systems over 14,500 Ha	-18.74	-6.7%	-16.26	-2.1%	24.30	35.4%	31.84	35.7%
Reduction in planted area by 20% + costs increase of agricultural operations and inputs by 10%	3.08	7.4%	11.74	9.8%	47.21	51.9%	61.38	52.1%
Reduction in planted area by 20% + costs increase of agricultural operations and inputs by 20%	-0.89	5.6%	7.08	8.3%	43.24	46.2%	56.72	46.4%

Reduction in planted area by 20% + costs increase of agricultural operations and inputs by 30%	-4.86	3.8%	2.42	6.8%	39.27	41.0%	52.06	41.2%

Conclusions

A detailed description of proposed models was provided in this economic and financial analysis. The returns of planned interventions are sufficiently high to justify the project from a financial point of view. Models yield solid prospects for avocado, orange and cacao-based agroforestry systems. The two Mampu systems modelled provide firewood and charcoal as a main product (in addition to stable food) and intend to stabilize agricultural production through rotational woodlots with the ultimate purpose of avoiding slash and burn practices. The financial outlook of the two modelled Mampu systems is lower than the other models but once the project covers part of the investment costs (through non-refundable grants) returns are sufficiently high to cover costs and still yield a valuable profit margin. The use of grants is needed for all models (including cacao-based systems, avocado and fruit orchards) because intended beneficiaries are not bankable for MFI and commercial banks. All models are expected to be replicable by improving access to finance (for which activities are planned under Component 3).

Once environmental benefits (consisting in avoided deforestation and GHG emissions reduction) are included in the analysis the results show that the returns of planned interventions are sufficiently high to justify the project also from an economic point of view

Appendix 1: Spreadsheet EFA

EFA.xlsx

Notes on the project budget and investment cost assumptions

The cost per hectare included in the budget is US$ 1,390 (and is increased annually for the assumed inflation rate). The details on how this cost is calculated are included the sheet named “Investment” of the excel spreadsheet (included in appendix of this Annex). The calculated cost is a weighted average of the investment costs included in Table 1. The weighting factors are the assumed distribution of the proposed five agroforestry systems over total land and the assumed distribution of three different categories of beneficiaries. The distribution of the agroforestry systems is the same used in this analysis (see Economic Analysis section). The distribution of beneficiaries (in terms of hectares) for GCF funding was assumed to be the following: 0.5% indigenous groups, 10% companies and 89.5% smallholders. The investments costs of these three categories of beneficiaries are slightly different since smallholders and indigenous groups are assumed to conduct part of the manual agricultural operations by using family labor (details are in the attached excel spreadsheet), while companies do not use family labor. In addition, the distribution of the planned agroforestry systems is likely to be different between the three groups (details are in the sheet named “investments” of the attached excel spreadsheet). The three groups of potential beneficiaries have different capacities to co-fund investments. Using the same approach of a WB-funded project promoting agricultural investments in the country, the project will request companies to co-fund 50% of the investment, smallholder groups or individuals to co-fund 20% of the investment, while for indigenous pygmies groups (typically the poorest part of the population) the project will co-fund fund 100% of the investment.