Food and Agriculture Organization of the United Nations

FUNDING PROPOSAL TO THE GREEN CLIMATE FUND

-IRES-CUBA-
INCREASED CLIMATE RESILIENCE OF RURAL HOUSEHOLDS AND COMMUNITIES THROUGH THE REHABILITATION OF PRODUCTIVE AGROFORESTRY LANDSCAPES IN SELECTED LOCALITIES OF THE REPUBLIC OF CUBA

ANNEX 3

ECONOMIC FINANCIAL ANALYSIS (EFA)

November 2019

Financial Analysis

1. An economic and financial cost-benefit analysis was carried out for the four agroforestry production modules and the two proposed silvopastoral modules of the IRES project, based on the technical information compiled from official sources and the information generated by the project formulation team. The flows of costs and benefits for the situation with and without the project were forecasted for a twenty-year period, which includes the seven-year project implementation period, in order to perform economic and financial analysis on the incremental benefit that is generated with the implementation of IRES, through the comparison of the current situation of the family farmers and the situation improvement promoted by the project.

2. The main purpose of the project is to restore critical ecosystem services in productive landscapes and increase climate-resilient, sustainable development in the provinces of Villa Clara, Matanzas and Las Tunas, encompassing seven highly vulnerable municipalities; it also includes the removal of Marabú trees that have encroached productive agricultural and rangeland.

   Marabú, *Dychostachys cinerea*, is an African invasive exotic species, which, partially through the impacts of climate change, as described in Appendix 2.9 of the FS, has spread alarmingly throughout Cuba's geography invading and rendering unusable for productive purposes large areas of land since the beginning of the last century; this species has become an alarming plant plague.

   The effect of Climate Change is also exerted on pastures in cattle areas, which are predominantly of grasses and have favored the expansion of Marabú, which has a high capacity for adaptation, recovery and growth. Considering the high costs of rehabilitation of lands invaded by Marabú, farmers who own land under these conditions do not have the economic capacity to make investments for their recovery; this helps to explain why these lands continue to be underutilized; limiting the development of production systems that allow the conservation of soil and water resources; as well as generating income to improve their living conditions and their adaptation to climate change.

   According to the criteria of experts from the Institute of Agroforestry Research, INAF, the Agroforestry Business Group, GAF and other specialists, not more than 3% of the total annual Marabú biomass is currently used for the production of charcoal and extraction of firewood. When it is utilized, this is generally spontaneous and without any management or authorization, resulting in very low positive economic contributions. because of this, for the economic and financial evaluation of the agroforestry modules, a situation without a project has not been considered, since the surface of the land to be intervened is unused and is invaded by Marabú. Therefore all the investments, costs and income would be incremental.

3. Market prices of inputs and outputs were considered for the projection of costs and benefits, as well as reference values for ecosystem goods and services obtained from peer-reviewed sources. A 20-year horizon was considered given the type of investments, as it reflects the full income flow and the project lifespan. To evaluate the financial and economic indicators in the medium term, a 10-year horizon was also projected. The analysis was completed with a financial discount rate of 12% and the following percentages of project area incorporation were considered: 10% of the area was

incorporated into the project in year 1, 20% in year 2, 30% in year 3, and 30% in year four, which means that the full incorporation is completed in year five with the remaining 10%. This is aligned to the project implementation schedule in Feasibility Study Annex 2.

In order to compare the financial indicators between the modules, the net benefit was estimated per hectare. Taking into account a 20-year horizon, the proposed models proved to be financially viable (see Table 1), except for the MARREG model. The incremental net present value and the internal rate of return ranged between - US$1,998 (IRR of 2.45%) and US$82,430 (IRR of 29.52%). The Annual Incremental Equivalent NPV, which is equivalent to the yearly incremental net present value, ranges from - US$268 to US$11,036. The results show that the models generate benefits for farmer families that are higher than the investment costs. The results for a 10-year horizon show that almost all of the project modules present a positive incremental net present value in a medium-term analysis, except for the agroforestry MARREG, MARFORM and FRUAGR models.

It should be remembered that MARREG has very particular characteristics when compared to the rest of the modules, since it is focused on the conversion of marabuzales into forests through assisted natural regeneration, a novel technique with the potential to scale up throughout the country. This module is based on soils of very low agro productivity with severe limiting factors (low effective depth, high rockiness, low organic matter content, etc.); in these areas it becomes more difficult to implement other agroforestry systems that require greater availability of labor, which is not always possible due to the remoteness of human settlements.

The MARFOM module seeks the implementation of multifunctional forest plantations on a large scale and with an optimum level of mechanization in areas infected by Marabú, constituting a safe and stable source of income and employment generation, improving the quality of life for families, which puts them in a less vulnerable situation in the face of extreme weather events that affect their homes. The timber exploitation of forest species included in this module begins with pruning and thinning practices, generating marginal income in year 8, with an 11% share of total income in 20 years. Full timber exploitation is reached until the year 20, due to the characteristics of forest species.

FRUAGR seeks to improve families' increased resilience to climate change; as well as to achieve greater stability in the supply of annual agricultural and perennial fruit products. These fruits will be marketed, generating income and jobs. This module has two characteristics that delay profitability; 1) the income of fruit species is only commercially reached in year 5; 2) the module includes annual crop production, which will generate permanent income from the first year; but due to limitations to irrigation availability it is not possible to establish crops in summer, reducing income and profitability in the medium term.

Table 1 shows the financial evaluation indicators of the agroforestry and silvopastoral modules of the IRES project, specifically, the net present value, the internal income rate and the equivalent annual NPV for planning horizons of 10 years and 20 years.

Table 1. Financial indicators per productive module:

Agroforestry and Silvopastoral Production Modules	NPV (US$/ha)	Internal Rate of Return	Equivalent Annual NPV (US$/ha)	NPV (US$/ha)	Internal Rate of Return	Equivalent Annual NPV (US$/ha)
	10 years horizon			20 years horizon		
I. CEDPLA - Irrigation system	$5,624	20.07%	$995	$20,840	21.90%	$2,790
I. CEDPLA – Reservoir	$2,946	15.72%	$521	$18,263	19.58%	$2,445
II: MARREG – natural regeneration	($2,161)	-9.26%	($383)	($1,998)	2.45%	($268)
III: MARFOM – fruit forests	($9,052)	0.00%	($1,602)	$82,430	29.52%	$11,036
IV: FRUAGR - Irrigation system	$16,148	27.82%	$2,858	$26,336	26.85%	$3,526
IV: FRUAGR – Reservoir	$19,352	29.06%	$3,425	$27,786	27.21%	$3,720
IV: FRUAGR – Season	($5,207)	-2.48%	($922)	$683	12.68%	$91
V: SILLEC – Drinkers	$774	14.76%	$137	$1,352	14.70%	$181
V: SILLEC – Reservoirs	$229	12.71%	$40	$806	13.42%	$108
V: SILLEC – Handling	$118	12.49%	$21	$18	12.04%	$2
VI: SILSOM – Drinkers	$1,402	14.95%	$248	$2,610	15.29%	$349
VI: SILSOM – Reservoirs	$1,069	14.06%	$189	$2,277	14.66%	$305
VI: SILSOM – Handling	$801	13.83%	$142	$1,331	13.92%	$178

4. A financial benefit was estimated for Component 1 ([1] (Increased climate change resilient production landscapes through investment in innovative agroforestry and sylvopastoral systems) that considered an investment cost of US $ 34.66 million contributed by the Green Climate Fund and US $ 76.29 million of national matching contribution. The general benefits were estimated by adjusting the net financial flow for each productive module for a 20-year horizon based on the total area included in each module, taking into account the gradual inclusion of the participants over five years. The total net financial present value of component 1 is estimated at US$ 115.98 million, with an internal rate of return of 19.8%. This means a financial net present value per hectare benefited of US$ 3,245.97, and a net present financial value for each participating household of US$ 7,263.83. This per household result refers to the average household considering the clustering in associations and the fact that different combinations of modules will be selected for planting in each area. For a 10-year horizon, the total net financial present value is estimated at - US$38.9 million, with an internal rate of return of 5.2%. The lower results, considering a medium-term horizon, can be explained by the gradual benefits of the proposed modules that will have a long-term effect.

5. A Monte Carlo simulation of Component 1 was performed to analyze the uncertainty, as part of the financial analysis using the Crystal Ball software. The results reveal that there is a probability of less than 1% of obtaining a negative net present value in the 20 years' time horizon. This probability is a proxy of the long-term financial risk of the project.

6. To evaluate the robustness of the financial feasibility of IRES, a sensitivity analysis was also performed, to evaluate how the financial indicators of the component 1 of the project change with variations in key variables:
   - Reductions in expected revenues from agriculture models.

[1] Components correspond to the Ouputs of the Project.

- Delay in benefit generation due to lags in project implementation
- Increment in investment costs.

Table 2 shows that the net present value of the component 1 of the project is still positive in financial terms even in the case of a reduction of 40% of expected benefits, a delay in benefit generation of 4 years and significant cost overruns. This reveals the robustness of IRES.

Table 2. Financial Sensitivity Analysis

Variable	Variation	Financial analysis	
		Total net present value US$	Internal Rate of Return
Reduction in benefits	-10%	$96915,471	19.0%
	-20%	$77842,052	18.0%
	-30%	$58768,633	16.9%
	-40%	$39695,214	15.7%
Delay in benefit generation	1 year	$95553,084	18.5%
	2 years	$77306,829	17.3%
	3 years	$61015,529	16.2%
	4 years	$46469,726	15.2%
Increment in investment costs	10%	$108514,360	19.1%
	20%	$101039,830	18.4%
	30%	$93565,300	17.7%
	40%	$86090,771	17.1%

7. The contributions of the Green Climate Fund are also a key element for the implementation of components 2 and 3 of IRES, as well as for the financing of the project management unit. Component 2, which will benefit the development of capacities to adapt to climate change, with the objective of establishing a structure that facilitates the transfer of knowledge and the development of capacities to promote adaptation interventions based on ecosystems. Component 3, which includes new mechanisms of financial incentives, to support inter-institutional dialogue and review and the needs in the legal and regulatory framework to incorporate adaptation to climate change. Therefore, the benefits of these components were included in the economic analysis presented below.

Economic Analysis

8. An economic analysis was performed to evaluate the incremental benefits of the project for society. The analysis considers two types of benefits: (i) commercial benefits derived from increases in the production of climate-resistant agroforestry and silvopastoral systems and (ii) the non-commercial benefits associated with the provision of ecosystem services as a result of the activities of landscape restoration, considering indicative monetary values for the provision of these services (per hectare / year). Since most of these services represent public goods, they are not captured by the markets and are rarely considered part of the decision-making processes. This analysis separated the benefits of carbon sequestration and storage from other climate benefits.

Economic Analysis for Agricultural Production

9. This economic analysis considers the same assumptions that were specified in the financial analysis of the agroforestry and silvopastoral modules, additionally, the economic analysis includes economic values. For this analysis a high economic discount rate of 12% was used, to add rigor, and different conversion factors, which have been used in similar studies in Cuba, to calculate the economic prices of products, labor, tools and equipment, among others.

10. An evaluation of the economic feasibility of the agricultural component of IRES was performed considering medium and long term horizon, obtaining as a result incremental net present values and internal rates of return that ranged from - US$21.8899 million to US$17.1829 million and 4.00% to 15.4%, respectively.

11. Table 3 shows the economic net present value of the agricultural component of IRES for a 10 and 20-year life span of the project, and the general economic net present value of the agricultural modules of this component, the general benefits were estimated by the extrapolation to the expected amount of hectares that will be implemented in each module, considering the gradual inclusion of participants over five years. The 10-year horizon is also presented.

Table 3. Economic Net Present Value of Agricultural Component of IRES and General Economic NVP of Agricultural Models

Elements	General Economic Net Present Value (NPV)		Weighted Percentage of
	10 Years	20 Years	Agricultural Modules of IRES
Agriculture Component	($21889,919.35)	$17182,943.19	100.00%
CEDPLA	($3557,432.00)	($2775,167.88)	-16.15%
MARREG	($150,934.46)	$10,913.91	0.06%
MARFORM	$4443,396.56	$26440,606.85	153.88%
FRUAGR	($80,792.29)	$2624,412.51	15.27%
SILLEC	($1647,618.45)	$3674,043.15	21.38%
SILSOM	$4055,166.63	$12159,839.98	70.77%
Green Climate Fund Investments in Component 1	($24951,705.33)	($24951,705.33)	-145.21%
Total:	($21889,919.35)	$17182,943.19	100.00%

i) Economic benefit from ecological services

12. The incremental economic benefits for the project are from the improvement and restoration of ecosystem services in the biomes that will be worked under the project (Woodlands and Grasslands). These ecosystem services represent public goods, which are not captured by markets or by the GDP and do not contribute to farmer's revenue, despite the fact that much of the cost required to ensure their provision are private costs paid by farmers. Ecosystem services were identified for each biome

and valued according to de Groot et al[2], 2012 adjusted to local parity purchase power and inflation. It is considered that the project will benefit 15,544 hectares of woodlands and 20,190 hectares of grasslands. It is assumed that these ecosystems currently have a capacity to provide ecosystem services at 60% of their potential (baseline) due to degradation. Therefore, the project will seek to restore their full capacity to provide ecosystem services. The values presented in the Table below will be considered as benefit for biome restoration. The same gradual inclusion of beneficiaries in over five years of hectares is considered.

Table 4. Monetary values for ecosystem service per biome (US$/ha/year)

Ecosystem Services	US$/hectare/year		Weighted average monetary value for the provision of ecosystem services (per hectare / year)
	Woodland	Grassland	
Erosion prevention	**7.8**	**26.4**	
TOTAL (US$/ha/year)	**7.8**	**26.4**	**$18.31**

The weighted average monetary value for the provision of ecosystem services of US$18.31/Ha/Year, was calculated based on the proportion of hectares benefited by landscape restoration of each biome, as detailed below:

$$\text{Weighted average monetary value for the provision of ecosystem services (per hectare / year)} = \frac{(\$7.8 \times 15{,}544\ \text{ha}) + (\$26 \times 20{,}189\ \text{ha})}{(15{,}544\ \text{ha} + 20{,}189\ \text{ha})} = \$18.31\ \text{ha/year}$$

ii) **Carbon sequestration and storage**

13. The incremental carbon benefits were modelled over a period of 20 years, although it is expected that the impact would last longer. A shadow price of US$50/tCO2 is the social value of carbon considered, with an annual incremental rate of 2.25% as a simple average of the low and high price estimate proposed by the World Bank [3] on shadow price of carbon in economic analysis. The expected emissions reduction over the assessment period (20 years) is estimated as 2,675,727 tCO2eq.

Results

14. The two indicated sources of benefits (agricultural production and climate) were aggregated to obtain the overall estimation of the economic value of IRES, considering the total investment cost of US$119.9 million, taxes excluded (US$38.2 million from Green Climate Fund and US$81.7 from National Matching Contribution). The economic benefit for the entire project is estimated in US $22.469 million, with an internal rate of return of 15.4%. In other words, with an investment of US$119.9 million, it is expected to create economic benefits in excess to the opportunity cost of capital (12%) and produce a bonus of US$22.469 million. This means an economic net present value per benefited hectare of US$628.81, an economic net present value per household of US$1,407.15 and an economic net present value per beneficiary of $439.73, considering 3.2 family members per household.

[2] Adjusted from de Groot, R., Brander, L., Ploeg, S., Costanza, R., Bernard, F., Braat, L., Christie, M., Crossman, N., Ghermandi, A., Hein L., Hussain, S., Kumar, P., McVittie., A., Portela, R., Rodriguez, L., Brink, P., van Beukering, P. 2012. Global estimates of the value of ecosystems and their services in monetary units. Ecosystem Services 1 (2012) 50–61. https://doi.org/10.1016/j.ecoser.2012.07.005

[3] World Bank, 2017. Guidance note on shadow price of carbon in economic analysis

15. Of the total economic benefits of US$22.469 million, 23.53% (US$5.286 million) are global in nature, relating to the provision of ecosystem services in the form of carbon sequestration; the remaining 76.47% (US$17.182 million) accrue to Cuba, in the form of the increased resilience of agriculture in the project areas.

Table 5. Economic benefit of IRES (US$ million)

Source of economic benefit	Net Present Value	Proportion
Agriculture economic benefits	$17.183	76.47%
Carbon sequestration	$ 5.286	23.53%
Total	$22.469	100.00%

16. An uncertainty analysis was performed on the economic analysis of IRES using a Monte Carlo Simulation. The results of uncertainty reveal that there is less than 1% of probability of obtaining a negative net present value in the long term for the project.

17. To evaluate the robustness of the economic behavior of IRES, a sensitivity analysis was also performed, to evaluate how the economic indicators of the project as a whole change with variations in key variables:
    - Reductions in expected fluxes of benefits from agriculture, ecosystem services and carbon sequestration during its lifetime.
    - Delay in benefit generation due to lags in project implementation
    - Increment in investment costs.
    - Variation in baseline of shadow price of ton of CO2 sequestered.

18. Table 6 shows that the overall net present value of the project is still positive in economic terms even in the case of a reduction of 20% of expected benefits, a delay in benefit generation of 2 years, significant cost overruns (20%) or a reduction in the social value of the carbon sequestered ($30). This reveals the robustness of IRES.

Table 6. Economic Sensitivity analysis

Variable	Variation	Economic analysis	
		Total net present value US$	Internal Rate of Return
Reduction in benefits	-10%	$12141,019	13.9%
	-20%	$1812,674	12.3%
	-30%	-$8515,671	10.6%
	-40%	-$18844,017	8.7%
Delay in benefit generation	1 year	$11403,280	13.6%
	2 years	$1522,848	12.2%
	3 years	-$7298,967	11.1%
	4 years	-$15175,587	10.2%
Increment in investment costs	10%	$14387,956	14.0%
	20%	$6306,547	12.8%
	30%	-$1774,862	11.8%
	40%	-$9856,271	10.8%
Base Shadow Price of Tco2 (US$)	$30	$234,501	12.0%
	$40	$11929,593	13.7%
	$60	$35319,776	17.5%

	$70	$47014,867	19.7%

19. The uncertainty and sensitivity analyses demonstrate that IRES can be considered as a low risk project in terms of expected economic benefits in long term.

20. The analysis shows that IRES is a robust project and creates economic value for society considering the productive, ecological and climate impacts.